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CIVIL ENGINEERING.

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Double Cylinder Expansion Marine Engines. By Alban C. Stimers, Chief Engineer U. S. Navy.

In the year 1781 Jonathan Hornblower obtained his patent for using two cylinders, one larger than the other, to get the benefit of the expansion of the steam, which, after impelling a small piston with steam of the boiler pressure, was to pass into the large cylinder and act upon the greater number of square inches with a less pressure per square inch, thus rendering the two cylinders approximately equal in power. This was before the days of "patent cut-offs," and indeed the intention of Hornblower was the same as that of the cut-off inventors of the present day, a moderate expansion only was intended, the steam was to follow the small piston during the whole stroke and steam of a very moderate pressure was to be used. After getting his patent, however, he could make no use of it as Watt's claims covered every variety of engine to which such a principle could be applied.

It is noteworthy that this patent of Hornblower's was the first public announcement that there was any benefit to be derived from the expansion of the steam when not flowing freely from the boiler; although Watt had made a practical application of the principle in an engine erected at Soho, near Birmingham, in 1776, five years before, by closing his induction valves before the piston had arrived at the end of the stroke in an ordinary single cylinder engine, as is the common practice at the present day.

Hornblower's mode of effecting the expansion has had many advo-

cates even since the introduction of excellent modes of effecting expansion in a single cylinder, but as a general rule it has only been by amateur engineers, and as a consequence, but few have been actually built.

The only application of them to marine purposes in this country which has fallen under my observation, were those of the steamboats *Independence*, *Oregon*, and *Buckeye State*. The first of these plied upon the Hudson River more than thirty years ago, and had what is known in this country as a square engine. The steam first acted upon two small pistons in vertical cylinders standing one upon each side of a large one, into which the steam passed from both the small cylinders after the completion of the stroke of their pistons. The piston-rods from each of the three cylinders were attached to the same crosshead.

The engine of the *Oregon* was a non-condensing horizontal one, built at Pittsburgh, Pa., in 1847, and the boat plied on our Northern Lakes during five or six years and was finally destroyed by fire in Chicago. The small high pressure cylinder was directly in the rear of the large low pressure one, a piston-rod passing through stuffing-boxes in the rear of the large, and the head of the small cylinder connected the two pistons rigidly together. This was a very awkward arrangement, as the steam, after acting upon the rear side of the small piston, had to traverse a steam pipe after leaving the cylinder, of more than twice the length of the stroke before it could act upon the front side of the large piston.

The following are the dimensions of the cylinders:

Length of stroke	10 ft.
Diameter of large cylinder,	48 ins.
" small "	28 "
Ratio of areas,	about 3 to 1.
No. of times the steam was expanded in the small cylinder,	none.
Consequent total number of times the steam was expanded,	three.
Pressure of steam carried in boilers,	80 lbs.

Although this engine was unpopular, it is generally acknowledged to have been economical upon fuel.

The *Buckeye State* was built in Cleveland, Ohio, in 1851 as a passenger boat for Lake Erie. The engine, with the exception of the cylinder, was the ordinary condensing, vertical, overhead beam, with lifting air-pump. The small high pressure cylinder was directly within the large low pressure one, which thus had necessarily an annular piston; both pistons were connected to the same crosshead by three piston-rods, one from the central and two from the annular piston. In this arrangement the steam was required to pass through pipes equal in length to the cylinders themselves after leaving the small piston before it could act upon the large one.

The cylinders were of the following dimensions:

Length of stroke,	11 ft.
Diameter of large cylinder,	40 and 80 ins.
" small "	37 "
Ratio of areas,	3½ to 1.
No. of times the steam was expanded in the small cylinder,	none.
Consequent total number of times the steam was expanded,	3½.
Pressure of steam carried in boilers,	50 lbs.

This boat would maintain the same speed as others of the same

dimensions running between Buffalo and Detroit on Lake Erie and consume but two-thirds the coal.

The mechanical performances of the engine were excellent, and it won its way through distrust and prejudice to high favor with all classes, and has at last only succumbed to the railroads, the same as all other paddle steamers on the Lakes.

In the course of a cruise in the Frigate *Merrimack*, in the year 1859, on the western coast of South America, I found that an English line of mail steamers—the Pacific Steam Navigation Company—had sent two vessels to England and had the double cylinder expansion engines of Randolph, Elder & Co. put into them, and that the result was a remarkable economy. At Callao the agent of the Company, Mr. Peters, sent an invitation through our Flag Officer for me to visit the Steamer *Callao*, at that time in port, in order that I might learn the particulars of what he believed was a great improvement in steam engineering. I accepted the invitation, and afterwards at Panama, by the polite invitation of Mr. Jameson, the chief engineer of the line, I visited the *Inca*, the *Valparaiso*, and the *Lima*. In the last named I made a trip down the Bay of Panama from the port to Taboga, a distance of nine miles, and thus had an opportunity to thoroughly examine the machinery when in operation. They are of beautiful workmanship, and I think I never saw machinery where the designer had been so entirely successful in combining compactness with easy access to every part requiring attendance, either when running or when overhauling for repairs.

There are two pairs of double cylinders, one forward and one abaft the paddle shaft. They are inclined to an angle with each other of ninety degrees and are direct-acting. There are but two crank-pins, one of which is articulated by the two small high pressure cylinders and the other by the two large low pressure cylinders, two connecting-rods engaging each crank-pin. The two pairs of cranks are directly opposite each other, and the small and large cylinders are side by side. Thus, when the small piston goes up the large one goes down and *vice versa*, making the steam passages from the high to the low pressure cylinders the shortest possible.

Description of Engine.	Space Occupied.		Weight.	
	Total.	Per cub. ft. of cylinder.	Total.	Per cub. ft. of cylinder.
	cub. feet.	cub. feet	lbs.	lbs.
The American overhead beam, (1 cylinder,)	14,000	44·408	280,000	885
The side lever, . . "	12,000	38 064	295,000	935
The oscillator, . "	8,000	25·376	220,000	697
The double cylinder expansion (4 cylinders,)	10,000	17 000	448,000	760

Although a strict comparison cannot be made, an idea of their compactness may be formed by the above spaces and weights required in the ship for a single engine. The side lever and oscillator having cylinders 85 inches diameter and 8 feet stroke, and the American beam an equal capacity, but of 70 inches diameter and 10 feet stroke.

The space occupied includes all passages about the engines, but not that part of the overhead beam which is up out of the way above deck.

The small cylinders have induction valves only. They are the grid-iron slide with sufficient lap to act as expansion valves. Between the small and large cylinders are slide valves of the ordinary character, without lap, having their faces toward the large cylinders, and when the port is uncovered by the valve the communication is free from the small to the large cylinder at one end and from the large cylinder to the condenser at the other. The cylinders are entirely surrounded with steam from the top of the steam drums of the boilers, where the temperature is from 100° to 150° F. higher than at the surface of the water. This superheating is effected by having steam drums 12 feet in height, with the uptakes from the tubes to the smoke pipe passing through them; the fire surface thus exposed to the steam being about 17·5 per cent. of the total fire surface.

As it may be useful to some readers to know the full dimensions of the vessel, boilers, and engines, I give them complete of the *Lima*, those of the *Valparaiso*, *Callao*, and *Bogota* being essentially the same.

Hull.—Length on deck, 257 ft. Length between perpendiculars, 251 ft. Breadth extreme, 30 ft. Depth of hold, 17 ft. Do. to spar deck, 25 ft. 4 ins. Length of engine space, including bunkers, 71 ft. Do. exclusive of do. 38 ft. 9 ins. Tonnage, (English old measurement,) 1115 44-94 tons. Do. (do. new do.) gross, 1461·24 tons. Do. (do.) engine room, 295·61 tons. Do. (do.) register, 1165·63 tons. Displacement at time of trial, 1345·00 tons. Area of midship section at do. 302 sq. ft. Draft of water at do. forward, 11 ft., aft, 12 ft. Speed at do. 12 knots.

Boilers.—Kind—Multitubular, horizontal fire tube, iron tubes. Number of pieces, two. Length of each, 12 ft. Breadth of each, 9 ft. 6 ins. Height, exclusive of steam drum, 13 ft. 6 ins. Do. inclusive of do. 25 ft. Number of tubes, 516. Diameter of do. outside, 4¼ ins., inside, 4 ins. Length of do, 6 ft. 6 ins. Number of furnaces, 6. Length of grate bars, 6 ft. 6 ins. Breadth of each furnace, 3 ft. 6 ins. Grate surface, 136·5 sq. ft. Fire surface, 3200 sq. ft. Ratio of fire to grate surface, 23·44 to 1. Diameter of smoke-pipe, 5 ft. Height of do. above grate, 45 ft. Cubic contents of water and steam space, 1000 cub. ft. Do. of combustion chambers and furnaces, 480 cub. ft. Air space through fire bars, about 50 sq. ft. Do. through tubes, 50 sq. ft. Do. through smoke-pipe, 19·6 sq. ft. Diameter of uptakes through steam drum, 2 ft. Number of do. six. Surface of do. exposed to steam, 560 sq. ft. Combustion of coal per hour at time of trial, 2590 lbs. Pressure of steam at do. 24 lbs.

Engines.—Kind—Inclined direct-acting, double cylinder expansion. Number of cylinders, four, two high pressure and two low pressure. Diameter of high pressure cylinders, 52 ins. Do. of low do. 90 ins. Ratio of areas, about three to one. Length of stroke, 5 ft. Area of steam passages, (6×24,) 144 sq. ins. Condenser, common jet, capacity, 400 cub. ft. Air pump, vertical single acting, lifting, capacity, 17 cub. ft. Vacuum at time of trial, 28 ins. Horses power at time of trial, 1150.

Paddle Wheels.—Kind—Feathering, with Penn's eccentrics and iron floats. Diameter over floats, 25 ft. 2 ins. Length of do. 8 ft. 2 ins. Breadth of do. 3 ft. Thickness of do. ¾-in. Number of do. in each wheel, twelve. Immersion at time of trial, 4 ft. Total weight of engines, 200 tons. Do. of boilers, 50 tons. Do. of water in do. 18 tons. Do. of both paddle wheels, 40 tons. Do. of coal when bunkers are filled, 250 tons.

The *Lima* and *Bogota* were in constant use 9000 miles from England, and were detached from their service in the line and sent this

great distance under steam, to have machinery removed which was of modern construction and in every respect mechanically good, to receive new, of a type which had yet to become known to the general engineering profession. Much more than ordinary advantages must be obtained by any engineering improvement to induce so conservative a body as an English steamship company to put themselves to so great an inconvenience and outlay.

The comparative economy of the old and the new machinery of these vessels may be gathered from the following several facts.—

The *Valparaiso*, with the new machinery, burned 640 tons of coal the round trip between Panama and Valparaiso, at the same time that the *Lima* and *Bogota*, with the old machinery, consumed 1150 tons.

The *Lima* was 48 steaming days in going from Callao to Liverpool, and burned 1900 tons of coal. On her return, after being fitted with the new machinery, she steamed only 42 days, and burned but 1000 tons of coal; and her commander, Capt. Wells, informed me that the weather was more favorable on the passage *to* England than on his return.

The *Bogota*, on her first passage out, in April, 1852, averaged on the passage to Madeira 9·75 knots with a consumption of 4256 lbs. of coal per hour. On her passage out, after receiving the new machinery, in September, 1859, she averaged on the passage to St. Vincent, Cape de Verde, 10·42 knots, with a consumption of 2128 lbs. per hour.

The Chief Engineer of the *Lima* informed me that her coal bills for the round trip of 5200 nautical miles, were 7500 dollars less than they were previous to the change in the machinery.

These are the crude facts which establish the great gain in economy of fuel; but, in addition to this, the tonnage of the vessels were considerably increased by the lesser weight and space of the new machinery, and the difference in the coals required to be carried.

It can easily be understood, therefore, why the company, after becoming convinced that the above results could be obtained, should put themselves to such great inconvenience and expense. It is, however, pretty well understood by American engineers, that English marine engines generally, though possessing great mechanical excellence, develop considerably less power per pound of coal than American engines. To enable the American engineer, then, to judge of the propriety of introducing machinery of that character into our steam marine, it is necessary to compare them with one of our most economical American engines. Those of the U. S. Frigate *Saranac* present, perhaps, the best sample that could be taken, as they are thoroughly American engines, and are very economical.

There is no question but that the boilers of the *Saranac* and those in general use in our navy at the present time, are decidedly superior to those which have been furnished to the Pacific Steam Navigation Company, by Randolph, Elder & Co. The question is, therefore, solely between the two kinds of engines.

To make a strict comparison between engines, independent of the boilers, it is necessary to compare the power obtained with the water

required to be evaporated. This can be done with little difficulty from correctly-taken indicator diagrams from engines in good working order. There is also a great advantage in this mode of comparison, in that no dependence is required to be placed upon the observations of those in attendance, always liable to be more or less erroneous, and in that it is not necessary to take a mean of a large number of diagrams: the examination of one set giving accurate results for the conditions which exist at the time they are taken.

The *Saranac* was completed in 1849. The engines were designed by C. W. Copeland, Esq., and built by Jabez Coney, of Boston. She originally had flue boilers of copper; but the great success of the *Martin Vertical Water Tube Boiler* led to their removal and the introduction of the latter type in 1857. Her engines, however, remain unchanged, except in the cut-off gear, which is quite unimportant in an economical point of view. The following are the dimensions of the vessel, boilers, and engines.—

HULL.—Length over all, 237 ft. Length between perpendiculars, 215 ft. Breadth, extreme, 38 ft. Depth of hold, 23 ft. 6 ins. Tonnage (Custom House measurement), 1440 tons. Draft of water at deep load, 17 ft. 9 ins. Displacement at above draft, 2290 tons. Area of midship section at above draft, 540 sq. ft. Speed in smooth water at sea with 393·5 horses power, 7 knots.

BOILERS.—Kind—Martin's patent vertical water tube; brass tubes. Number of pieces, two. Length of each, 10 ft. 6 ins. Breadth of each, 20 ft. 5 ins. Height of each, exclusive of steam drum, 11 ft. 3 ins. Do., inclusive of do., 13 ft. 3 ins. Number of tubes, 2860. Diameter of do., inside, 1 8-10 ins., outside, 2 ins. Length of do., 2 ft. 9 ins. Number of furnaces, 12. Length of grate bars, 6 ft. Breadth of each furnace, 2 ft. 9½ ins. Grate surface, 201 sq. ft. Fire surface, 6009 sq. ft. Ratio of fire to grate surface, 30 to 1. Diameter of smoke-pipe, 6 ft. 4 ins. Height of do. above grate, 60 ft. Air space through fire-bars, about 80 sq. ft. Do. through tube boxes, 27·5 sq. ft. Do. through smoke-pipe, 31·5 sq. ft.

ENGINES.—Kind—Inclined direct-acting. Number of cylinders, two. Diameter of do., 60 ins. Length of stroke, 9 ft. Condenser, common jet. Air pump. Inclined piston pump.

PADDLE WHEELS.—Kind—Common radial; wooden floats. Diameter over floats, 27 ft. 6 ins. Length of floats, 9 ft. Breadth of do., 2 ft. 6 ins. Number of do. in each wheel, 22. Immersion at above draft, 6 ft. 4 ins.

The cylinders of the *Saranac* are well surrounded by felt and wooden lagging, but there are no steam jackets; neither is the steam superheated.

The following are the observed conditions at the time the diagrams in the adjoining plate were taken. The engines of the *Valparaiso* differ from the others in not having the cylinders surrounded with steam, except in the cylinder bottoms of large cylinders, and in all cylinder covers. These diagrams were taken from the engines when doing their ordinary every-day work; it being the rule, both in our navy and in that line of steamers, to take one complete set each day, and place them on file. One-half only of each set examined are given in the plate.

The curved lines drawn upon the diagrams, marked M, show the true expansion curve, according to the law of MARIOTTE. Those

marked R in the diagrams from the *Saranac*, show the modification of MARIOTTE'S law, which is effected by the slight superheating of the steam during expansion, according to the laws of steam as given by REGNAULT. The dotted lines along the expansion curves of the diagrams, represent the true pressure in the cylinder.

	SARANAC.	VALPARAISO.	CALLAO.
Pressure of steam in the boilers,	12 lbs.	19½ lbs.	18 lbs.
Vacuum in the condenser,	26 ins.	26 ins.	26 ins.
Position of throttle valve,	Wide open.	4 ins. open.	
Temperature of hot-wells,	110° F.		
Pounds of coal used per hour,	1470	2240	1960
Kind of coal,	Anthracite.	Scotch, Welsh, & patent fuel.	
Per centum of ashes and clinker,	21	15	15

When the induction valve is closed and the pressure suddenly commences to fall, the indicator piston is a little behind-hand in its movements, and then when it does start, its momentum carries it a little too far. In applying the dotted line, I have been compelled to rely entirely upon my experience and judgment in such matters. If any engineer thinks they are incorrect, he can easily retrace them to suit himself, and modify my results accordingly.

DIAGRAM No. 1.

a Part of Stroke.	*b* Pressure by MARIOTTE'S Law.	*c* Corresponding Temperature.	*d* Corresponding total heat required to maintain the pressure in column *b*.	*f* Total heat actually in the steam.	*g* Difference available for superheating the steam, *f*—*d*.	*h* Increase of pressure due to this superheating.	*k* Consequent actual pressure, *b*+*h*.
	lbs. sq. in.	F°.	F°.	F°.	F°.	lbs. sq. in.	lbs. sq. in.
Commencement,	25·	241·	1187·47	1187·47	0·	0·	25·
1/8	25·	241·	1187·47	1187·47	0·	0·	25·
A 1/4	22·	233·8	1185·16	1187·47	2·31	0·125	22·125
3/8	14·666	211.89	1178·61	1187·47	8·86	0·264	14·930
1/2	11·	197·54	1174·03	1187·47	13·44	0·301	11·301
5/8	8·8	187·39	1170·67	1187·47	16·80	0·301	9·101
3/4	7·333	175·57	1168·53	1187·47	18·94	0·283	7·616
7/8	6·285	172·63	1166·39	1187·47	21·80	0·279	6·564
End,	5·5	168·1	1165·17	1187·47	22·30	0·250	5·750

DIAGRAM No. 2.

Commencement,	26·25	243·85	1188·32	1188·32	0·	0·	26·25
1/8	26·25	243·85	1188·32	1188·32	0·	0·	26·25
1/4	26·25	243·85	1188·32	1188·32	0·	0·	26·25
A 5-16	25·625	.....	.....	.....	.....	.....	.....
3/8	21·354	232·12	1184·74	1188·32	3·58	0·155	21·509
1/2	16·015	216·30	1179·92	1188·32	8·40	0·273	16·288
5/8	12·812	205·	1176·47	1188·32	11·85	0·309	13·121
3/4	10·677	196·13	1173·77	1188·32	14·55	0·316	10·993
7/8	9·152	189·74	1171·82	1188·32	16·50	0·307	9·459
End.	8·008	183·2	1169·82	1188·32	18·50	0·301	8·309

To obtain the expansion curve of MARIOTTE, the pressure was measured on the diagram at A and the calculations are made as if the stroke commenced at the line B; the space between that and the commencement of the diagram being the length of the cylinder which would be equal in capacity to the clearance between the valves and the piston at the end of the stroke. It will be observed that the measurement of the pressure at A for a *point d'appui* of the expansion curve is exactly

what is effected by the correction of the line traced by the indicator shown by the dotted line.

As I have observed in a recent publication that REGNAULT'S expositions of the laws of steam are sometimes misunderstood, I give in the foregoing table the exact method by which REGNAULT'S curve of expansion has been found in the two diagrams from the *Saranac* given in the plate.

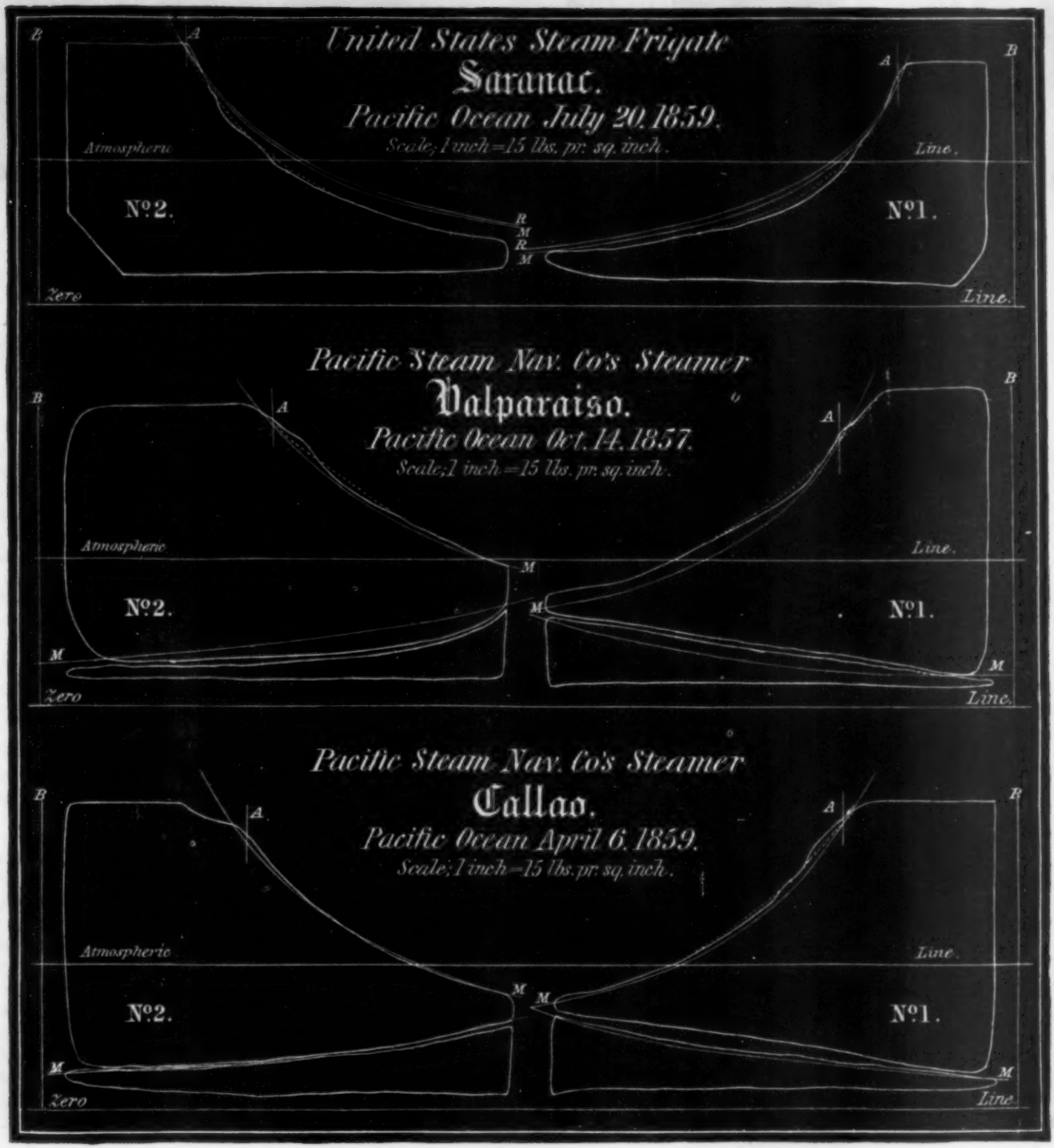
The temperatures in column *c* were taken from the well known table of the pressures and temperatures of steam given in all engineering pocket-books. Where the pressures in column *b* were not found exactly in the table, the increase of temperature between the next higher and next lower tabular pressure was assumed to be proportional to the increase of pressure, which is not rigorously true, but is nearly so, for the small differences employed. The total heat required to maintain the pressure, column *d*, was taken from REGNAULT'S tables. Where the temperature in column *c* were not found exactly in the table the difference was obtained between the given and the next lower tabular temperature, and this multiplied by 0·305 gave accurately the amount which was required to be added to the tabular total heat. The increase of pressure was obtained upon the rule of REGNAULT that it was doubled by the addition of 494° Fahr.

From this table it would appear that where the heat of the steam is neither increased nor diminished by extraneous influences, any expansion of the steam causes it to be superheated and not condensed, as some have erroneously asserted, basing their assertion upon the laws of steam as given by REGNAULT.

A little reflection must also convince any one not carried away by a kind of scientific fanaticism that the yielding of the piston in the cylinder to the pressure upon it affects the steam only by giving it an opportunity to expand. What then becomes of Prof. JOULE'S theory that condensation is caused by a rendition of power on the part of the steam? It is painful to know that such absurd doctrines are advanced by men of learning and position, and that they are proved to be correct, and adopted into the calculations of others equally learned and high in position.

In the subjoined tables will be found the calculations of the diagrams from the engines of the three vessels compared, tabulated in such a way as to enable any engineer to judge of the correctness of the results obtained and to insert his own corrections at the proper point wherever he may consider it necessary.

In obtaining the amount of steam condensed in the cylinders of the *Saranac* before the point of cutting off, I was necessarily compelled to assume that the cylinder remained constantly at the same temperature during the different fluctuations of the steam within it—as to attempt a calculation of the amount of its fluctuations during the stroke would be a refinement which I consider is much better left out of all investigations of this kind. If it could be accurately known and employed the result of the calculation would be a greater amount of condensation previous to cutting off than has been arrived at in the table. Because, when the steam first entered the cylinder the temperature of


United States Steam Frigate
Saranac.
Pacific Ocean July 20. 1859.
Scale; 1 inch = 15 lbs. pr. sq. inch.
Atmospheric Line.
No. 2.
No. 1.
Zero Line.
Pacific Steam Nav. Co's Steamer
Valparaiso.
Pacific Ocean Oct. 14. 1857.
Scale; 1 inch = 15 lbs. pr. sq. inch.
Atmospheric Line.
No. 2.
No. 1.
Zero Line.
Pacific Steam Nav. Co's Steamer
Callao.
Pacific Ocean April 6. 1859.
Scale; 1 inch = 15 lbs. pr. sq. inch.
Atmospheric Line.
No. 2.
No. 1.
Zero Line.

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the latter is below the mean, but when the piston is at the commencement of the ¼ stroke which has been taken for a measure of the condensation, the metallic surfaces with which the steam is in contact has been heated to a temperature above the mean, and during this ¼ stroke its temperature is still going up, so that the difference between the temperatures of the steam and the surfaces with which it is in contact is not so great during the above ¼ stroke as between the steam and the mean temperature of the cylinder given in the table. The condensation per unit of surface and unit of difference in temperature is, therefore, greater than that arrived at in the table. At the same time the difference between the temperatures of the steam and the surfaces with which it comes in contact before cutting off is greater than between the steam and the mean temperature of the cylinder, so that this greater condensation per unit should be multiplied by a greater difference of temperature than is given in the table.

In calculating the condensation of the different diagrams the unit in the fifth column only was used.

One-fourth only of the stroke was used to find the unit for calculating the condensation and that taken immediately after the starting point of the expansion curve of the diagrams, because during the latter part of the stroke the temperature of the steam gets below that of the cylinder and the condensation not only ceases but evaporation takes place, which is not only very reasonable, but may be observed in the diagrams of the *Saranac* given in the plate, while during the ¼ stroke made use of the temperature of the steam was always above that of the cylinder.

The loss by blowing off has been taken at about the average of sea-going ships when the existence of scale is ignored, and the same for all. It is put into the account of the engines because it is an attachment of the engines and not of the boilers which prevents this loss.

In computing the number of times the steam is expanded the ratio is found between the space filled with steam at the point of cutting off and the space filled at the end of the stroke. The steam really expands as much more than this as there is condensation beyond the point of cutting off. That is, however, a kind of expansion that requires no "precedents" to prove it unbeneficial.

In calculating the diagrams of the *Valparaiso* and *Callao* I labored under the difficulty of not knowing the amount of space in the clearances of the piston and the steam passages. I estimated this amount for the small cylinders to be equal to 3½ inches in length of cylinder for the upper end and 4 inches for the lower end. This may appear large until it is remembered that these cylinders have, not only the ordinary induction passages, but in addition there are the peculiar eduction passages to the large cylinders, within which, as in a steam chest, are the slide valves of the large cylinders. With regard to the clearances in the large cylinders I was guided entirely by the amount which the pressure of the steam fell at the end of the stroke of the small piston and the commencement of the stroke of the large piston, as shown by the diagrams accounting the spaces filled to be inversely as the pressures indicated.

TABLE *showing the Method employed and Results obtained in Calculating the Economy of the Engines of the Saranac.*

	Diagram No. 1.	Diagram No. 2.	Diagram No. 3.	Diagram No. 4.	The four diagrams combined.
Pressure in pounds per square inch of the steam in the cylinder at the point of cutting off,	25·	26·25	24·5	23·6	
Cubic feet of space in cylinder and clearances filled with steam of the above pressure,	41·0365	57·2678	43·2945	55·9589	
Number of revolutions made by the engines per minute,	12·	12·	11·5	11·	
Relative volume of saturated steam of the above pressure and water,	1044·	1015·	1064·	1101·	
Pounds of water in the form of steam of the above pressure, at the time of cutting off, per hour,	1768·8	2580·	1754·75	2081·4	8184·95
Total heat in saturated steam of the above pressure, F.°	1187·47	1188·32	1187·11	1186·36	
do do atmospheric pressure, F.°	1178·6	1178·6	1178·6	1178·6	
Additional number of pounds which the same heat would therefore evaporate to atmospheric pressure,	13·2	21·	11·75	13·6	59·55
Mean temperature of steam during the full stroke of the piston, F.°	200·	211·19	196·95	200·4	
do do forming the back pressure during the return stroke of the piston, F.°	142·64	153·24	144·41	146·4	
Consequent mean temperature of the cylinder, F.°	176·76	176·76	172·04	172·04	
Mean temperature of the steam during the ¼ stroke of piston next after the point A of the diagrams, F.°	209·8	221·4	213·	215·2	
Difference between temperature of steam and mean temperature of cylinder during the above ¼ stroke, F.°	33·04	44·64	40·96	43·16	
Number of pounds weight of steam condensed per hour in the above ¼ stroke,	291·1	300·	248·5	240·2	
Number of square feet of surface in contact with the steam at the commencement of the above ¼ stroke,	92·49	105·77	92·49	105·77	
do do do do end do do	129·77	143·05	129·77	143·05	
Mean do do do during do do	111·13	124·41	111·13	124·41	
Fraction of complete revolution made by the engine do do do	·094	·089	·094	·089	
Number of pounds weight of steam condensed per hour per unit of surface and unit of difference in temperature	·8434	·6069	·5807	·5026	·6334
Difference between temperature of steam and mean temperature of cylinder before the point of cutting off, F.°	64·24	67·09	67·86	65·7	
Mean number of square feet of surface in contact with the steam before cutting off,	32·51	42·75	36·96	42·	
Fraction of complete revolution made by the engine from the commencement of the stroke until steam is cut-off,	·14	·1722	·1444	·17	
Number of pounds weight of steam condensed in the cylinder before cutting off, to be added to the evaporation given above,	185·19	312·83	229·38	297·13	1024·53
Number of pounds weight of steam which represent 12 per cent. loss by blowing off to keep the saturation down in the boilers,	268·25	397·34	272·16	326·2	1263·95
Total number of pounds weight of steam which represent the heat expended upon the engines per hour in obtaining the power,	2235·44	3311·17	2268·04	2718·33	10532·98
Number of times the steam is expanded in the cylinder,	4·54	3·28	4·3	3·35	3·79
Mean effective pressure on the piston in pounds per square inch,	9·6	13·52	9·7	11·	
do do would have been if there had been no condensation in cylinder after steam was cut off,	10·38	14·72	10·66	12·2	
Consequent per centums of loss of useful effect by condensation in cylinder after steam was cut off,	7·52	8·15	9·	9·83	8·63
Per centums of the steam actually evaporated, condensed in the cylinder before cutting off,	9·41	10·73	11·49	12·42	11·05
Total per centums of loss by condensation in the cylinder,	16·93	18·88	20·49	22·25	19·68
Mean back pressure on the piston in pounds per square inch,	2·8	3·52	2·85	3·07	3·08
Per centums of loss of useful effect by back pressure,	22·58	20·65	22·70	21·84	21·94
Horses power developed upon the piston,	89·1	12·51	86·	93·3	393·5
Number of pounds weight of steam which represent the heat expended upon the engines per hour per H. P.	25·089	26·468	26·372	29·135	26·767

TABLE *showing the Method employed and the Results obtained in Calculating the*

TABLE *showing the Method employed and the Results obtained in Calculating the Economy of the Engines of the Pacific Steam Nav. Co.'s Steamers,*

	VALPARAISO.					CALLAO.				
	Diagram No. 1.	Diagram No. 2.	Diagram No. 3.	Diagram No. 4.	The four diagr'ms combi'd.	Diagram No. 1.	Diagram No. 2.	Diagram No. 3.	Diagram No. 4.	The four diagrams combined.
Pressure in pounds per square inch of the steam in the small cylinder previous to cutting off,	32·1	30·25	32·5	30·25		31·5	31·	32·25	30·	
Cubic feet of space in small cylinder and clearances filled with steam of the above pressure,	23·7	36·4	23·965	36·4		35·333	30·11	31·09	28·65	
Number of revolutions made by the engine per minute,	20·5	20·	20·5	20·		19·5	19·5	19·5	19·5	
Relative volume of saturated steam of the above pressure and water,	831·	877·	821·	877·		845·	857·	827·	883·	
Pounds of water in the form of steam of the above pressure at the time of cutting off, per hour,	2193·	3112·87	2244·	3112·87	10662·74	2057·5	2569·2	2749·3	2372·75	10748·75
Total heat in saturated steam of the above pressure, F.°	1192·	1190·83	1192·2	1190·83		1191·54	1191·26	1191·98	1190·66	
do do atmospheric pressure, F.°	1178·6	1178·6	1178·6	1178·6		1178·6	1178·6	1178·6	1178·6	
Additional number of pounds which the same heat would therefore evaporate to atmospheric pressure,	25·	32·13	25·8	32·13	115·06	33·5	27·6	41·2	24·25	116·55
Number of pounds weight of steam condensed in steam jackets of cylinders, allowing 1·94 per cent, to be thus condensed,	43·88	62·22	44·9	62·22	213·22					
Number of pounds weight of steam condensed in steam jackets of cylinders, allowing 5 per cent. to be thus condensed,						162·68	136·67	146·34	126·16	571·85
Number of pounds weight of steam which represent 12 per cent. loss by blowing off to keep the saturation down in the boilers,	308·43	437·34	315·64	437·34	1498·75	443·68	372·74	399·11	344·06	1559·6
Total number of pounds weight of steam which represent the heat expended upon the engines per hour in obtaining the power,	2570·31	3644·56	2630·34	3644·56	12489·77	3397·36	3106·21	3225·95	2867·22	12996·75
Number of cubic feet of space filled with steam at the end of stroke of large piston,	239·	254·8	239·	254·8		244·	248·	244·	248·	
Number of times the steam is expanded in the cylinders,	10·08	7·	9·97	7·	8·19	6·76	8·23	7·84	8·65	7·86
Mean effective pressure on small piston in pounds per square inch,	15·24	19·03	14·75	19·03		15·	16·725	16·675	15·175	
do back do do do	6·25	5·53	7·42	5·53		7·	5·825	7·925	5·7	
Per centums of loss of useful effect by back pressure on small piston,	29·1	22·5	23·46	22·5		31·8	25·8	32·2	27·3	
Mean effective pressure on large piston in pounds per square inch,	3·4	2·32	3·34	2·32		3·625	3·675	4·037	3·25	
do back do do do	2·34	2·7	3·2	2·7	2·73	2·5	1·875	2·75	2·125	2·56
Per centums of loss of useful effect by back pressure on large piston,	40·7	53·7	49·	53·7		40·8	33·6	40·5	39·5	
do do do in the two cylinders combined,	34·9	38·1	41·23	38·1	38·	36·3	29·7	36·35	33·4	33·95
Pressure in pounds per square inch of small piston, which it is estimated would overcome the friction of itself and its immediate connexions,	1·25	1·25	1·25	1·25		1·25	1·25	1·25	1·25	
Horses power developed upon the small piston,	100·53	122·46	97·3	122·46	442·75	94·118	104·942	104·628	95·216	398·904
do do do after the above friction is deducted,	92·29	114·42	89·06	114·42	410·19	86·245	97·069	96·755	87·343	367·412
do do large piston,	67·18	44·72	66·	44·72	222·62	68·135	69·075	76·	61·185	274·395
Total horses power, with the extra friction, inherent to double cylinder engines, deducted,	159·47	159·14	155·06	159·14	632·81	154·38	166·144	172·755	148·528	641·807
Number of pounds weight of steam which represent the heat expended upon the engines per hour, per horse power,	16·117	22·901	16·963	22·901	19·737	23·301	18·696	18·673	19·304	20·25

The clearances of the *Saranac* are equal to 6 inches length of cylinder at the upper end and 6·8 inches at the lower end.

In obtaining the weight of the water evaporated from the diagrams of the *Valparaiso* and *Callao* I have treated it as though saturated steam was used; this gives a slight excess of the true amount of even that which would be evaporated by the heat contained in it, but the error is very small, and could not be corrected because the exact amount which the steam was superheated at the time the diagrams were taken is not noted on them, and I am informed that it varies considerably at different times.

It is estimated by English engineers familiar with the steam jacket, that five per cent. of the steam raised in the boiler is condensed in the jacket. This amount appears rather small when the great number of expansions are considered, but it must not be forgotten that the steam is superheated both when entering the cylinder and the jacket. Mr. Jameson was intending to ascertain by direct experiment how much was thus condensed, but when I left the Pacific it had not yet been done. The bottoms of the large cylinders and all cylinder covers being the only steam jackets around the cylinders of the *Valparaiso* amount to 38·8 per cent. of their whole surface, and 5 per cent. of this is (38·8 × ·05 =) 1·94 per cent.

Collecting the data contained in the foregoing we have the following results and comparisons between the engines *per se*, the boilers *per se*, and of them both combined.

	Saranac.	Valparaiso.	Callao.	Mean between Valparaiso and Callao.
Actual Performances.				
Pounds of steam required per hour per H. P.,	26.767	19·735	20·25	19·993
Pounds of water evaporated per lb. of coal,	7.165	5·575	6·631	6·103
" " per lb. of combustible,	9 070	6 597	7·807	7·202
Pounds of coal required per hour per H. P.,	3·735	3·540	3·054	3·297
" combustible " "	2·911	3·010	2 596	2·803
Relative Performances.				
Ratio of power obtained per unit of water evaporated,	1·000	1·356	1·321	1·338
Ratio of water evaporated per unit of coal consumed,	1·000	0·778	0·922	0·850
Ratio of water evaporated per unit of combustible consumed,	1·000	0·728	0·860	0·793
Ratio of power obtained per unit of coal consumed,	1·000	1·055	1·223	1·139
Ratio of power obtained per unit of combustible consumed,	1·000	0·967	1·121	1·044

From this exhibit it would appear that there is no doubt about the superiority of the *engines* of the *Valparaiso* and *Callao* over those of the *Saranac*, but in comparing the two sister vessels together we get the best results from the engines which are only partially steam jacketed, but it is evident from the appearance of the diagram from the top end of the cylinder (*Valparaiso* No. 1) that the induction valve leaked, and the evaporation given in the tables is therefore deficient to the extent of the leak.

As the same coals were used in both vessels the true evaporation per pound of coal is very probably nearly the same.

The ratio of excellence of the *engines* of the two vessels, as per the above table, stands:

Valparaiso 1·000; *Callao* 0·974.

But if the same amount of water is really evaporated by the boilers of each, the ratios would stand:

Valparaiso 1·000; *Callao* 1·154.

They would then compare with the *Saranac* as follows:

Saranac 1·000; *Valparaiso* 1·138; *Callao* 1·321.

It is evident from the tables that a much greater economy could be obtained from these engines by simply increasing the pressure, so that the per cent. of loss by the back pressure in the large cylinder would be reduced. In the *Valparaiso* this is now 49·1 and in the *Callao* 38·6. To double the pressure would reduce this loss one-half. This could be done without much increasing the pressure in the boilers by permitting the steam to follow the small piston farther. It will be observed that the horses power of the small cylinders is the greatest in each case; if, therefore, they were to follow the small piston far enough to make the power of the large piston a little the greatest it would of itself reduce the above loss considerably, while the loss by the diminished number of times the steam would be expanded, would be comparatively very small.

Report of the Committee on Gas Works, presented to the Select and Common Councils of the City of Philadelphia, April 19, 1860.

To the Select and Common Councils of the City of Philadelphia.

The Committee on Gas Works, to whom were referred the following resolutions, viz:

"*Resolved*, By the Select and Common Councils of the City of Philadelphia, that the Committee on Gas Works be instructed to inquire and report whether the manufacture of gas from any materials other than those now in use at the Philadelphia Gas Works, is practicable; and if so, whether such gas can be manufactured at a cheaper rate than is now charged, and if so, at what rate; and whether such gas gives an equal or greater degree of light than that manufactured from coal; and if thought practicable, what cost will be incurred in change of apparatus, &c., and any other information relative to the subject, which they may deem important.

"*Resolved*, That they be further instructed to inquire and report from what cause (if it can be ascertained,) the bills of consumers of gas have been, of late, so largely increased; whether from defective meters, or from inferior quality of gas furnished, or from other causes.

"*Resolved*, That the Committee be instructed to report at as early a day as convenient."

Respectfully report—That, in reference to the first resolution, the Committee are not, as yet, prepared to report.

In pursuance of the second resolution, directing inquiry into the cause of the recent increase in the amount of gas bills, it seemed right for the Committee first to ascertain whether the increase referred to, had any existence, in fact.

For this purpose, a statement has been compiled from the Bill Books of the Gas Offices, exhibiting all the bills issued in the months of December, January, and February, during four successive years, to all consumers, who, for that time, have continued to use gas in the same premises, in the wards comprising the old city proper, Moyamensing, Spring Garden, Penn Township, and West Philadelphia.

This statement comprises the bills of 11,114 consumers, to whom more than 44,000 bills were issued during the four winters.

It appears that the bills of 3259 of the consumers, or not quite one-third, are higher in the last winter than in those of the three previous years, and the bills of 7855, or rather more than two-thirds, are not higher than those for previous years.

The aggregate amount of all the bills to these consumers, in the winter of

1856–57	was	$138,177·70
1857–58	"	125,762·24
1858–59	"	137,923·36
1859–60	"	141,368·54

the increase of 1859–60, over 1856–57, being $3190·84, or about 2¼ per cent.

The reports of the Inspectors of fittings show that in the interval between 1856 and 1859, the number of additional lights, put on by the consumers included in the foregoing statements, is 8300, or about 6 per cent. increase of lights, if these customers are supposed to have in use the average number of lights, which is shown by the published reports to be twelve to each consumer.

From this it appears, that the amount of gas used has not increased as much as the number of lights in use; and a similar result is exhibited by comparing the whole quantity of gas sold in the year with the whole number of lights in use at the beginning of the year. For example, the number of lights reported to Councils, as in use in January, 1856, was 300,406, and the cubic feet of gas sold in that year was 415,888,950, being 1384 feet to each light. The lights reported in use in January, 1859, was 378,462, and the cubic feet of gas sold in that year was 494,128,345, being 1305 feet to each light, or 5½ per cent. less than before.

These comparisons have been carried back so as to include four years in order to avoid the erroneous conclusions which would result from taking only the past two years, which included a period of commercial depression, the effects of which are very marked upon the consumption of gas by certain classes of consumers; among whom the various manufacturers present very conspicuous examples; while among other classes not thus affected by business, the quantity of gas consumed has been curiously regular, sometimes the bills for three

or four successive winters not materially varying in amount, and in thousands of instances not differing so much as one dollar for several years. The aggregate amount of the bills for the periods of commercial distress, and also the average consumption per light in use, are shown to be diminished in a remarkable degree, and gives strong confirmation to the other proofs elicited by this laborious investigation, of the carefulness and accuracy with which the books and accounts of the City Gas Trust are kept.

The table of annual consumption per light, compiled from the published reports to Councils, shows the average amount of gas used per light to be less in 1859 than in any other of the eighteen years elapsed since the City has owned the Gas Works, except 1857 and 1858, when the consumption was so much reduced by the suspension of business.

In addition to the statements exhibiting the foregoing facts, relating only to consumers who have been supplied during four successive years, two others have been prepared, embracing all those consumers who have used gas during the last two winters, in Southwark and Kensington.

These comprise two bills for each of 3408 consumers, amounting to 6816 bills, and make an aggregate of more than 50,000 bills, whose amounts, making a total of $543,231·84, have been examined and compared in this investigation.

In the first named district the gas was derived from the City Works during both winters; but in the former season, received only an inadequate supply, in consequence of the imperfect communication between the local main of the Southwark Gas Company, and those of the City, from which the supply was drawn; which defects were removed in the summer of 1859.

The aggregate of the bills here, on the 1st of March, 1859, was $10,652·79, and in March, 1860, was $11,683·24, the increase being $1030·45, or not quite 10 per cent.

In Kensington, the bills rendered by the Northern Liberties Gas Company, on the first of April, 1859, amounted to $12,573·42; and those by the City Gas Works, to the same consumers for the corresponding period in 1860, amount to $10,224·74, the former amount being greater by $2348·68, or 22 per cent. over the latter.

Part of this gain to the people of Kensington, results from the lower price now paid per one thousand cubic feet; but the books show that nearly one-half of it is in the saving of gas consumed, which is nearly 10 per cent. less since their supply from the City Works. It is proper to remark, in this connexion, that the saving to the City of cost of gas for public lighting, by the purchase of the Kensington Gas Works, is about $5000 a year; while the quantity of light in the streets is generally greater since the change in the source of the supply.

In Southwark, out of 1618 bills rendered, 1029 were larger in 1860, than in 1859, and 589 were not larger.

In Kensington, out of 1790 bills rendered, 378 bills were larger in 1860, than in 1859, and 1412 were not larger.

The unavoidable conclusion to which the Committee has arrived,

after a careful consideration of the foregoing facts, is that there has been no general increase in the amount of gas bills, nor any local increase that is not evidently the result of an increased facility of supply; and moreover, that an examination of the accounts of the many thousands of gas consumers kept in the offices of the City gas trust will satisfy every unbiased mind as to the regularity and reliability of the records of consumption given by the instruments used for the measurement of gas.

The voluminous statements compiled from the bill books for the use of the Committee are kept open to the inspection of any member of Councils, and indeed of any citizen, who may desire to examine them, and thus form his own judgment as to the accuracy of the statistics that have been derived from their critical analysis.

WM. ROTCH WISTER,
WILSON KERR,
J. E. ELDRIDGE,
GEORGE READ,
} *Committee on Gas Works.* {
CHARLES T. JONES,
WM. BRADFORD,
O. H. P. PARKER,
STEPHEN BENTON,

Philadelphia, April 19th, 1860.

RECAPITULATION.

CITY.

First Section. North of the North Side of Market Street, from Delaware to Schuylkill, due February 1,

1857	1858	1859	1860
$34,115·70	$30,262·73	$34,286·45	$34,516·75

Second Section. From North Side of Market Street to South Side of Walnut Street (inclusive) from Delaware to Schuylkill Rivers, due December 1,

1856	1857	1858	1859
$29,554·60	$26,319·92	$28,617·36	$30,253·20

Third Section. South of the South Side of Walnut Street to South Street (inclusive) from Delaware to Schuylkill Rivers, due January 1,

1857	1858	1859	1860
$31,306·77	$29,674·85	$32,487·00	$32,040·10

Monthlies. From Vine Street to South Street (inclusive) from Delaware to Schuylkill Rivers, due

	1856–7	1857–8	1858–9	1859–60.
December 1,	$4483·64	$4107·41	$4729·48	$4670·58
January 1,	4438·14	4882·41	4728·81	4849·50
February 1,	5380·71	4245·81	4446·30	4690 25
Total,	$14,302·49	$13,235·63	$13,904 59	$14,210·33

SPRING GARDEN.

First Section. East of Twelfth Street and North of Vine Street, all Streets running North and South, due December 1,

1856	1857	1858	1859
$5977·56	$5728·48	$6131·75	$6711 95

Second Section. East of Twelfth Street, and North of Vine Street, all Streets running East and West, due January 1,

1857	1858	1859	1860
$6916 86	$6532·86	$7113·91	$7378·35

Third Section. West of Twelfth Street, all Streets North of Vine Street, due February 1,

1857	1858	1859	1860
$8554·41	$6903·45	$8300·76	$8929·51

Monthlies. North of Vine Street, from Sixth Street, &c., to Schuylkill River, due

	1856–7	1857–8	1858–9	1859–60
December 1,	$503·97	$474·73	$517·26	$551·25
January 1,	675·04	654·32	613·35	619·43
February 1,	552·35	559·36	567·21	604·47
Total,	$1731·36	$1688·41	$1697·82	$1775·15

MOYAMENSING.

Due, Dec. 1st,

1857	1858	1859	1860
$4251·89	$4036·38	$3970·95	$4104·00

WEST PHILADELPHIA.

Due,	1857	1858	1859	1860
January 1,	$919·33	$879·80	$872·82	$901·82
February 1,	546·73	503·73	539·95	547·38
	1466·06	1383·53	1412·77	1449·20
Total,	$138,177·70	$125,762·24	$137,923 36	$141,368·54
Grand Total,		.	$543,231·84	

KENSINGTON.

Due, April 1st,

1859	1860	1859	1860
$12,573·42	10,224·74 cubic feet	5,029,370	cubic feet 4,544,328

or about 22 per cent. more in 1859 than in 1860.

378 bills greater in 1860 than in 1859.
1403 " less " "
9 " identical " with "

Total, 1790 Bills.

SOUTHWARK.

Due, March 1st,

1859	1860
$10,652·79	$11,683·24

1029 bills greater in 1860 than in 1859.
473 " less " "
116 " identical " with "

Total, 1618 Bills.

SUMMARY.

Showing the proportion of bills in the last winter, that are greater, or less, or identical with those of previous years.

	Greater.	Less.	Identical.	Total.
Old City Proper,	1979	4550	851	7380
Spring Garden,	1070	1401	491	2962
Moyamensing,	164	331	101	596
West Philadelphia,	46	101	29	176
Total, .	3259	6383	1472	11,114

Number of instances of Identical Bills in the four years.

	2 Bills.	3 Bills.	4 Bills.
Old City Proper,	1559	88	43
Spring Garden,	822	55	39
Moyamensing,	169	9	13
West Philadelphia,	45	5	2
Total, . .	2595	157	97

Year.	Lights in use January 1st.	Gas sold during the year.	Cubic feet per light.
1842	24,996	49,888,830	1995
1843	28,080	47,565,751	1693
1844	31,557	53,631,156	1699
1845	36,682	54,076,598	1746
1846	42,558	74,547,300	1751
1847	50,792	89,700,993	1766
1848	66,822	105,663,050	1581
1849	84,523	134,003,850	1583
1850	110,591	181,267,500	1639
1851	129,027	195,212,325	1517
1852	143,441	209,574,250	1461
1853	168,381	248,120,995	1473
1854	200,848	279,307,174	1340
1855	222,989	293,800,915	1313
1856	300,406	415,888,950	1384
1857	338,592	432,052,884	1276
1858	357,729	444,631,979	1242
1859	378,462	494,128,345	1305

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*On the Efficiency of various kinds of Railway Brakes; with Experimental Researches on their Retarding Powers.** By Mr. W. FAIRBAIRN, M. Inst. C. E.

The present communication was based upon an inquiry which arose out of a report prepared by Col. Yolland, R. E., for the Railway Department of the Board of Trade. That report gave the results of a large number of experiments, with heavy trains at high velocities, made with the steam brake of Mr. McConnell, the continuous brake of Mr. Fay, the continuous and self-acting brake of Mr. Newall, and the self-acting brake of M. Guérin. The conclusions arrived at being favorable to the brake of Mr. Newall, as well as, partially, to that of M. Guérin, for some descriptions of heavy traffic, Mr. Fay made application to the directors of the Lancashire and Yorkshire Railway, for a further investigation of the subject. This permission was granted, and the author agreed to arrange the conditions of the trial, and to superintend the experiments.

*From Newton's London Journal, May, 1860.

The objects the author had in view were—first, to ascertain the respective retarding power of each of the competitive brakes; and, secondly, to obtain some data in regard to the rapidity with which a train, with an engine and tender attached, could be brought to a stand, when traveling at a high rate of speed; so as to determine the value of the continuous and self-acting brakes, as compared with those ordinarily in use, and with others recently introduced. To enable this comparison to be made, the experiments were reduced to a common standard, by means of a few dynamical laws, which were explained.

It was stated that, in the increase of the braking power of trains, the principles hitherto most successfully employed, had been,—first, the use of steam acting direct on the brakes; second, the connexion of several of the ordinary form of brakes, so as to have them under the control of a single brakesman; and, third, the introduction of braking apparatus connected with the buffers, so as to make the momentum of the train itself available in generating a retarding force.

A description was then given of the different brakes before alluded to as having been experimented upon by Colonel Yolland. It was mentioned, that Mr. Newall claimed the earlier application of a combination of brakes, acted upon by one guard through a longitudinal shaft; and that Mr. Fay had adopted the same principle, with very slight modification, either in form or in construction.

The mode of carrying out the experiments with Mr. Newall's and Mr. Fay's continuous brakes was then detailed, and the results obtained were recorded in seven tables, one for each set of trials. As, in the reductions, the value of the retarding force of the brakes was found in terms of the co-efficient of friction of the rubbing surfaces, the efficiency of the brake varied with the condition of the weather. Thus, the mean of the Oldham experiments gave a retarding force of 1·7987 feet per second; the mean of the first experiments at Southport 4·2978, and of the second 3·3245. On each day the experiments were consistent with one another, but they varied greatly, on different days, from the change in the condition of the rubbing surfaces. At Oldham, the experiments were made with the rails in a greasy condition from fog; at Southport, in the first trial (Table 2), with the rails dry, and in the best state for braking, and in the second (Table 3), with the rails slightly wet. These results were in accordance with the experiments of Morin, on the friction of iron on iron, from which it was found that the co-efficient of friction varied from 0·05 to 0·3, according as the surfaces were greasy, wet, or dry. The remaining experiments were all made under the most uniform and favorable conditions. They were, therefore, grouped together under the following heads:—

1. On the friction of the carriages (Table 4).
2. With slide brakes, and the engine detached (Table 5).
3. With flap brakes, and the engine detached (Table 6).
4. With the engine attached to the train (Table 7).

The following table gave a brief summary of all the experiments except those on the friction of the carriages, which was found to

amount to 11·527 lbs. per ton weight of train in Mr. Fay's case, and to 7·627 lbs. per ton in that of Mr. Newall:—

	No. of Experiments.		Average efficiency of Brake.	
	Mr. Fay.	Mr. Newall.	Mr. Fay.	Mr. Newall.
Oldham Incline, Table 1,	7	7	1·8538	1·7136
Southport " " 2,	5	1	3·6256	4·9700
" " " 3,	1	1	3·2329	3·4161
" " " 5,	8	8	6·7030	5·4984
" " " 6,	3	3	5 8718	6·3272
" " " 7,	3	3	3 0934	3·0250

The general average from this table gave, for the efficiency of Mr. Fay's brake, 4·0634, and for Mr. Newall's, 4·1650, showing a slight superiority in favor of the latter. The following conclusions seemed to be borne out by the experiments:—1. That with slide brakes, the greater number of experiments gave a manifest superiority to Mr. Fay. 2. That with flap brakes, there was a decided advantage on the side of Mr. Newall. 3. That when the train was braked, with the engine attached, the results were uniform, neither gaining any decided superiority.

Colonel Yolland's experiments were then tabulated, and reduced in the same manner as the author's, so as to admit of comparison with them. The results thus arrived at, in reference to two of the systems, were exhibited in the annexed summary:—

	Mr Newall.	Mr. Fay.	Remarks.
Engine Detached,	3·5516	3·9345	Dry.
	3·017	3·255	Wet.
Engine Attached,	4 671	.....	Mean 4·774.
	5 146		
	4 505		

The final reduction of the retarding force, to units of weight of the brake carriages, was given in the following general summary:—

Brake.	Weather.	Experimenters.	Ratio of Weight on the Brakes to the Retarding Force generated by them, or the Mean Co-efficient for each Brake.
Mr. Newall's,	Dry.	Fairbairn.	From 0·1544 to 0·1965
"	Wet.		0·0542
Mr. Fay's,	Dry.		From 0·1126 to 0·2082
"	Wet.		0 0576
Mr. Newall's,	Dry.	Yolland.	From 0·1116
Mr. Fay's,	Dry.		0·1020
Mr. Ingram's,	Wet.		0 1075
M. Guérin's,	Dry.		0·01048
Mr. McConnell's,			02·8325

Showing that the retarding force varied from the one-hundredth to five-eighteenths of the weight of the carriages to which brakes were applied, and was ordinarily from one-tenth to one-fifth.—*Proc. Inst. Civ. Eng.* April 17, 1860.

MECHANICS, PHYSICS, AND CHEMISTRY.

*On Platinum and its associated Metals.** By MM. DEVILLE and H. DEBRAY.

The *Annales de Chimie et de Physique* for August last contains a very elaborate article by the above chemists on the subject of platinum and the metals which accompany it. The results at which they have arrived are so important, and they are moreover of such interest, that we are induced to lay before our readers a few of the principal facts contained in their memoir.

The metallurgy of platinum is altogether a modern art, the introduction of the metal into the laboratories of science and industry dating but from a few years back; and although particularly deserving the attention of the chemist, the metallurgy of platinum and its congeners is, in general, but little known. Except for chemical purposes, platinum has not hitherto received any important application; but when we know better where to look for its ores, and when the deposits already known are more extensively worked, the ores of platinum will, perhaps, become no rarer than gold; and as the metal is almost indestructible, and as its value protects it from losses and accidents of all kinds, it must in time accumulate and thus become more plentiful. It may then perhaps be applied to other useful purposes in which its weight and slightly tarnished color will be no objection, or for which its absolute unalterability will give it a peculiar value. The solution of these questions, however, depends on the price for which the metal can be supplied; and the chemist is particularly interested in seeing its cost so far reduced that the large vessels of the laboratory may be made of platinum. It was in the hope of facilitating a progress of this kind, that MM. Deville and Debray undertook the difficult researches the results of which are given in the above-mentioned memoir, a work which has cost them more than four years of labor.

Until the first communications of M. Deville were published, no one dreamt of utilizing all the metals found with platinum, and with the exception of palladium and osmium, which there was always a motive for separating, platinum alone has been extracted from the ores, leaving a residue which has accumulated in all the manufactories in Europe as well as in the Russian Mint.

The processes described are exclusively by the dry way, and by fusion at a very high temperature. They are given in different chapters, which treat of "the revivification of pure platinum," "the metallurgy of pure platinum," "the extraction from the rough ore of a triple alloy of platinum, rhodium, and iridium of a suitable and invariable composition;" and lastly, the extraction, whether from the residues or from the osmide of iridium, of the utilizable metals, platinum, palladium, rhodium, and iridium.

We give first, the methods practised for obtaining pure platinum, reserving for a future occasion the interesting accounts of the indivi-

*From the Lond. Chemical News, No. 1.

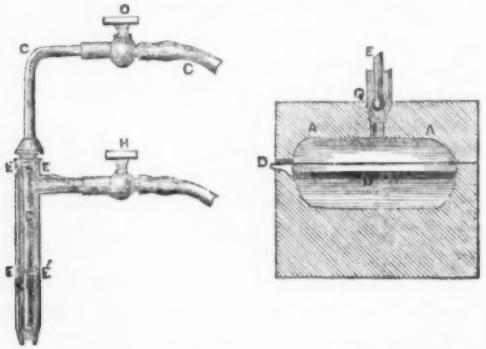
dual metals, and the methods for assaying the rough ores, metals, and residues.

In commerce, platinum is found which is almost free from iridium, but which still contains traces of osmium and a little silicium. MM. Deville and Debray have discovered that fusion in lime by means of an oxidizing flame, refines it perfectly, osmic acid being disengaged, and the silicium becoming converted into silicate of lime, which melts into a colorless bead, and moves rapidly about on the surface of the metal until it reaches the edge, where it is absorbed by the sides of the furnace. Platinum so melted and refined is a metal as *soft* as copper; it is whiter than ordinary platinum, and does not possess the porosity which has hitherto been an obstacle to the manufacture of an impermeable platinum sheath.

Melted platinum still possesses the property of condensing gases at its surface, and of producing the phenomenon of a lamp without flame. Its density=21·15—less than the density of ordinary platinum which has been subjected in the working to a powerful hammering (*d'un écrouissage extrémement energique*).

We now proceed to describe the apparatus by means of which platinum has been melted, in quantities relatively considerable, and run into ingots, like a metal of ordinary fusibility.

The fuel most often employed has been common coal-gas, but hydrogen may be used, and when pure will give even a greater heat. The combustion is fed by a current of oxygen. The furnace in which the fusion is made, is of lime bound with iron wire. It is composed of two parts: 1, The roof A A, made of a cylindrical piece of lime slightly arched on its lower surface, and pierced by a conical hole Q, through which a blowpipe C E is to pass; and, 2, a bottom B, made of another piece of lime, hollowed as shown in the diagram. The hollow should be scooped out so deep, that the melted platinum may occupy a depth of 3 or 4 millimetres or more. At the anterior part D, a groove inclined a little towards the inside is made with a file, which is to serve as a hole for the metal to run out of and for the flame to issue from.



The blow-pipe is composed of a copper cylinder E E, terminated at its lower extremity by a slightly conical tube E′ E′, made of platinum.

A copper tube CC, having a platinum nozzle, enters the first cylinder at its upper extremity, and is so arranged as to allow the nozzle to be slid up or down, and placed at any height from the lower end of the cylinder EEE′E′, that may be wished.

A stop-cock H, is attached to the side of the cylinder E, by means of a tube as large as the cylinder itself. Another stop-cock O, terminates the elbow of the tube C. It is by the stop-cock H, that the hydrogen or coal gas passes, and the oxygen is introduced through the stop-cock O.

When the fusion is to be made, the pieces of lime composing the furnace are put together in the way represented in the diagram. Then, holding the blow-pipe in the hand, the stop-cock H, is opened so as to allow the passage of a gentle stream of gas which is lighted, and the stop-cock O, is turned to admit the oxygen necessary for the combustion. The flame is in this way plunged into the apparatus by the hole Q, in such a manner as to avoid an explosion, which might disturb the pieces of lime. The body of the furnace is now gradually heated; the quantity of the gases passing being increased by degrees until the maximum temperature is attained. The degree of heat may be raised or lowered as need be, by raising or lowering the platinum nozzle which supplies the oxygen. The temperature is now lowered, and the platinum is introduced, by little and little, through the opening D. When it is in thin slips of less than a millemetre in thickness there is scarcely time to introduce them. They are seen to melt and disappear almost at the moment they enter the furnace. The oxygen should arrive at a regular pressure of about four or five centimetres of mercury, and ought to give a rotary movement to the platinum so as to equalize the temperature throughout the mass.

When it is not wished to run the metal into a mould, the fusion being perfect, and the refining completed, which is the case when no more vitreous matter is seen to form on the surface, the two gases are turned off by degrees, always leaving the oxygen in a decided but very slight excess. The mass now gradually solidifies, and the flame may be completely extinguished. A little of the metal is always thrown up to the roof of the furnace, where it may be easily collected after the operation is finished.

When the platinum is to be cast, an ingot mould is prepared of thick cast iron, well rubbed with plumbago, or of coke or lime. The last are most easily made of plates of the substance, sawn, and held together by iron wire. The roof of the furnace is taken off, the body seized with a pair of tongs, and the platinum is poured out, without hurrying, just as we should any other metal. The only difficulty which occurs, and this a little practice will enable the operator to overcome, is to discern at the same time the dazzling surface of the metal and open mouth of the mould, before turning up the crucible. A larger quantity than 3 or 4 kilogrammes should never be cast in this way, inasmuch as there would be great danger of some part of the apparatus giving way.

For greater quantities, the authors describe how a larger furnace

may be made of several pieces of lime bound firmly together with iron; an ingenious and simple arrangement, by means of which the metal may be poured out without taking up the bottom part of the apparatus. The reasons they give for preferring to use lime in the construction of the furnace are as follows:—

1. Lime is perhaps the worst conductor of heat known; so much so, that through a thickness of at most 2 centimetres (0·8 inch), the apparatus being full of melted platinum, the temperature of the outside is barely 120° (Cent.)

2. Lime radiates heat most perfectly. For this reason it is the best material for the sides of a reverberatory furnace of this kind.

3. Lime acts on all the impurities from which we wish to free platinum—iron, copper, silicium, &c., changing them into fusible compounds, which are absorbed by its porous substance. It acts like a cupel, the material purifying the metal melted in it.

An experiment made in the laboratory of the *Ecole Normale* showed that the quantity of oxygen required to melt 1 kilogramme (2·2 lbs. Avoird.) of platinum was only 60 litres (about 13 gallons), the cost of which was estimated at 0·4 of a franc. The cost of the coal gas or hydrogen used was not considered worth taking into account.

The process applied to the revivification of old platinum gives excellent results. No foreign metal except iridium and rhodium can exist in platinum after it has been melted and refined in the method described. All the substances which most easily attack platinum, sulphur, phosphorus, arsenic, gold, soda, iron, copper, palladium, and osmium, are separated either by oxydation and absorption by the lime or by volatilization. Gold and palladium escape in the form of vapor, and may be easily collected by making the flame which issues from the furnace pass through an earthenware tube, in which will be deposited all the volatile matters except the osmic acid, which may be condensed if the vapor is made to pass over a vessel full of ammonia. A part of the osmium is also deposited in the tube in a metallic state.

The only caution to be observed in the process is never to have the bath of metal of more than 4 or 5 centimetres thickness without keeping it in constant agitation; because the platinum is too bad a conductor to remain perfectly liquid if it is in greater depth; and, therefore, there will be a chance of the refining not being complete, or of the perfect fusion of the mass not being quite effected.

Coal Oil as a preservative for Sodium and Potassium.

The following statement is sent to us by an anonymous correspondent.

To the Editor of the Journal of the Franklin Institute.

Coal oil is a better article for preserving sodium and potassium than naphtha. In coal oil, sodium keeps its lustre for months or years; while, in the purest naphtha, it loses it in a few days.

Yours, &c., A. C.

Philadelphia, May 22, 1860.

A Course of Six Lectures (adapted to a Juvenile Auditory), consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces—including an Account of their Relations to each other.** By M. FARADAY, D.C.L., F.R.S., Fullerian Professor of Chemistry, R. I., Foreign Associate of the Academy of Sciences, Paris, &c.

LECTURE I. (Dec. 31, 1859.)—*The Force of Gravitation.*

It grieves me much to think that I may have been a cause of disturbance in your Christmas arrangements, for nothing is more satisfactory to my mind than to perform that which I undertake; but such things are not always left in our own power, and we must submit to circumstances as they are appointed; I will to-day do the best I can; I will ask you to bear with me if I am unable to give more than a few words; and as a substitute I will endeavor to make the *illustrations* of the sense I try to express, as full as possible; and if we find by the end of this lecture that we may be justified in continuing them, thinking that next week our power shall be greater—why then, with submission to you, we will take such course as you may think fit; either go on or discontinue them; and although I now feel much weakened by the pressure of illness (a mere cold) upon me, both in faculty of expression and clearness of thought, I shall here claim, as I always have done on these occasions, the right of addressing myself to the younger members of the audience,—and for this purpose, therefore, unfitted as it may seem for an elderly infirm man to do so, I will return to second childhood and become, as it were, young again amongst the young.

Let us now consider, for a little while, how wonderfully we stand upon this world. Here it is we are born, bred, and live, and yet we view these things with an almost entire absence of wonder to ourselves respecting the way in which all this happens. So small, indeed, is our wonder, that we are never taken by surprise; and I do think, that, to a young person of ten, fifteen, or twenty years of age, perhaps the first sight of a cataract or a mountain would occasion more surprise in him than he had ever felt concerning the means of his own existence; how he came here; how he lives; by what means he stands upright; and through what means he moves about from place to place. Hence, we come into this world, we live, and depart from it, without our thoughts being called specifically to consider how all this takes place; and were it not for the exertions of some few inquiring minds, who have looked *into* these things and ascertained the very beautiful laws and conditions by which we *do* live and stand upon the earth, we should hardly be aware that there was any thing wonderful in it. These inquiries, which have occupied philosophers from the earliest days, when they first began to find out the laws by which we grow, and exist, and enjoy ourselves, up to the present time, have shown us that all this was effected in consequence of the existence of certain *forces* or *abilities* to do things, or *powers*, that are so common that nothing can be

* From the Lond. Chemical News, No. 5.

commoner; for nothing is commoner than the wonderful powers by which we are enabled to stand upright—they are essential to our existence every moment.

Now, it is my purpose to-day to make you acquainted with some of these powers; not the vital ones, but some of the more elementary, and, what we call, *physical* powers; and in the outset, what can I do to bring to your minds a notion of neither more nor less than that which I mean by the word *power* or *force?* Suppose I were to take this sheet of paper, and were to place it upright on one edge resting against a support before me, (as the roughest possible illustration I can give of something to be disturbed), and suppose I pull this piece of string which is attached to it. I pull the paper over. I have, therefore, brought into use a *power* of doing so—the *power* of my hand carried on through this string in a way which is very remarkable when we come to analyze it; and it is by means of these powers conjoined together (for there are several powers here employed) that I pull the paper over. Again, if I give it a push upon the other side, I bring into play a *power*, but a very different exertion of power from the former; or, if I take now this bit of shellac [a stick of shellac about 12 inches long and 1½ in diameter] and rub it with flannel, and hold it an inch or so in front of the upper part of this upright sheet, the paper is immediately moved towards the shellac, and by now drawing the latter away, the paper falls over without having been touched by anything. You see—in the first illustration I produced an effect than which nothing could be commoner—I pull it over now, not by means of that string or the pull of my hand, but by some action in this shellac. The shellac, therefore, has a *power* with which it acts upon the sheet of paper; and as an illustration of the exercise of another kind of power, I might use gunpowder with which to throw it over.

Now, I want you to endeavor to comprehend that when I am speaking of a *power* or *force*, I am speaking of that which I used just now to pull over this piece of paper. I will not embarrass you at present with the *name* of that power, but it is clear there was a *something* in the shellac which acted by attraction, and pulled the paper over; this, then, is one of those things which we call *power* or *force;* and you will now be able to recognise it as such in whatever form I show it to you. We are not to suppose that there are so very many different powers; on the contrary, it is wonderful to think how few are the powers by which all the phenomena of nature are governed. There is an illustration of another kind of power in that lamp; *there* is a power of heat—a power of doing something, but not the same power as that which pulled the paper over; and so, by degrees, we find that there are certain other powers (not many) in the various bodies around us; and thus, beginning with the simplest experiments of pushing and pulling, I shall gradually proceed to distinguish these powers one from the other, and compare the way in which they combine together. This world upon which we stand (and we have not much need to travel out of the world for illustrations of our subject; but the mind of man is not confined like the matter of his body, and thus he may and does travel outwards, for wherever his sight can pierce, there his observations can penetrate,)

is pretty nearly a round globe, having its surface disposed in a manner of which this terrestrial globe by my side is a rough model; so much is land and so much is water, and by looking at it here we see in a sort of map or picture how the world is formed upon its surface. Then, when we come to examine further, I refer you to this sectional diagram of the geological strata of the earth, in which there is a more elaborate view of what is under the surface of our globe. For, when we come to dig into or examine it (as man does for his own instruction and advantage, in a variety of ways), we see that it is made up of different kinds of matter, subject to a very few powers; and all disposed in this strange and wonderful way, which gives to man a history—and such a history—as to what there is in those veins, in those rocks, the ores, the water springs, the atmosphere around, and all varieties of material substances, held together by means of *forces* in one great mass, 8000 miles in diameter, that the mind is overwhelmed in contemplation of the wonderful history related by these strata (some of which are fine and thin like sheets of paper),—all formed in succession by the forces of which I have spoken.

Now, I shall try to help your attention to what I may say, by directing, to-day, our thoughts to one kind of power. You see what I mean by the term *matter*—any of these things that I can lay hold of with the hand, or in a bag (for I may take hold of the air by enclosing it in a bag)—they are all portions of matter with which we have to deal at present, generally or particularly, as I may require to illustrate my subject. Here is the sort of matter which we call *water*—it is *there* ice [pointing to a block of ice upon the table]—*there* water [pointing to the water boiling in a flask]—*here* vapor—you see it issuing out from the top [of the flask]. Do not suppose that that ice and that water are two entirely different things, or that the steam rising in bubbles and ascending in vapor *there* is absolutely different from the fluid water—it may be different in some things, having reference to the *amounts* of power which it contains; but it is the same, nevertheless, as the great ocean of water around our globe, and I employ it here for the sake of illustration, because if we look into it we shall find that it supplies us with examples of all the powers to which I shall here refer. For instance, here is water—it is heavy; but let us examine it with regard to the *amount* of its heaviness or its gravity. You see here I have a little glass vessel and scales [nearly equipoised scales, one of which contained a half-pint glass vessel], and the glass vessel is at present the lighter of the two; but if I now take some water and pour it in, you see that that side of the scales immediately goes down; that shows you (using common language, which I will not suppose for the present you have hitherto applied very strictly), that it is *heavy*, and if I put this additional weight into the opposite scale, I should not wonder if this vessel would hold water enough to weigh *it* down. [The Lecturer poured more water into the jar, which again went down.] Why do I hold the bottle *above* the vessel to pour the water into it? You will say, because experience has taught me that it is necessary. I do it for a better reason —because it is a law of nature that the water should fall towards the

earth, and, therefore, the very means which I use to cause the water to enter the vessel are those which will carry the whole body of water down. That power is what we call *gravity*, and you see *there* [pointing to the scales] a good deal of water gravitating towards the earth. Now *here* [exhibiting a small piece of platinum] is another thing which gravitates towards the earth as much as the whole of that water. See what a little there is of it—*that* little thing is heavier than so much water [placing the metal in opposite scales to the water]. What a wonderful thing it is to see that it requires so much water as *that* [a half pint vessel full] to fall towards the earth, compared with the little mass of substance I have *here;* and again, if I take this metal [a bar of aluminium about eight times the bulk of the platinum], we find the water will balance that as well as it did the platinum; so that we get, even in the very outset, an example of what we want to understand by the words *forces* or *powers*.

I have spoken of water, and first of all of its property of falling downwards—you know very well how the oceans surround the globe—how they fall round the surface, giving roundness to it, clothing it like a garment; but, besides that, there are other properties of water. *Here*, for instance, is some quick-lime, and if I add some water to it, you will find another power or property in the water. It is now very hot, it is steaming up, and if I had a bit of phosphorus here, or a match, I could perhaps light it. Now that could not happen without a *force* in the water to produce the result; but that force is altogether very different from its power of falling to the earth. Then, again, here is another substance [some anhydrous sulphate of copper] which will illustrate another kind of power. [The Lecturer here poured some water over the white sulphate of copper, which immediately became blue, evolving considerable heat at the same time.] Here is the same water with a substance which heats nearly as much as the lime does, but see how differently. So great indeed is this heat in the case of lime, that it is sufficient sometimes (as you see here) to set wood on fire; and this is the reason of what we have sometimes heard, of barges laden with quick-lime taking fire in the middle of the river, in consequence of this power of heat brought into play by a leakage of the water into the barge. You see how strangely different subjects for our consideration arise, when we come to think over these various matters—the power of heat evolved by acting upon lime with water, and the power which water has of turning this salt of copper from white to blue.

I want you now to understand the nature of the most simple exertion of this power of matter called *weight* or *gravity*. Bodies are heavy—you saw that in the case of water when I placed it in the balance. Here I have what we call a *weight* [an iron half cwt.]—a thing called a weight, because in it the exercise of that power of pressing downwards is especially used for the purposes of weighing; and I have also one of these little inflated india-rubber bladders which are very beautiful although very common (most beautiful things are common), and I am going to put the weight upon it, to give you a sort of illustration of the downward pressure of the iron, and of the power which the air

possesses of resisting that pressure—it may burst, but we must try to avoid that. [During the last few observations the Lecturer had succeeded in placing the half cwt. in a state of quiescence upon the inflated india-rubber ball, which consequently assumed a shape very much resembling a flat cheese with round edges.] There you see a bubble of air bearing half a hundred weight, and you must conceive for yourselves what a wonderful *power* there must be to pull this weight downwards, to sink it thus in the ball of air.

Let me now give you another illustration of this power. You know what a pendulum is. I have one here (Fig. 1.), and if I set it swinging, it will continue to swing to and fro. Now, I wonder whether you can tell me why that body oscillates to and fro—that pendulum bob as it is sometimes called. Observe, if I hold this straight stick horizontally, as high as the position of the ball at the two ends of its journey, you see that the ball is in a higher position at the two extremities than it is when in the middle. Starting from one end of the stick, the ball falls towards the centre, and then rising again to the opposite end it constantly tries to fall to the lowest point, swinging and vibrating most beautifully, and with wonderful properties in other respects—the time of its vibration and so on—but concerning which we will not now trouble ourselves.

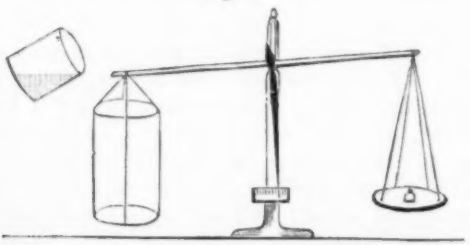
Fig. 1.

If a gold leaf, or piece of thread, or any other substance, were hung where this ball is, it would swing to and fro in the same manner and in the same time too. Do not be startled at this statement; I repeat, in the same manner and in the same time, and you will see by-and-by how this is. Now, that power which caused the water to descend in the balance—which made the iron weight press upon and flatten the bubble of air—which caused the swinging to and fro of the pendulum, that power is entirely due to the attraction which there is between the falling body and the earth. Let us be slow and careful to comprehend this. It is not that the earth has any *particular* attraction towards bodies which fall to it, but, that *all* these bodies possess an attraction, every one towards the other. It is not that the earth has any special power which these balls themselves have not, for just as much power as the earth has to attract these two balls [dropping two ivory balls], just so much power have they in proportion to their bulks to draw themselves one to the other; and the only reason why they fall so quickly to the earth is owing to its greater size. Now, if I were to place these two balls near together I should not be able by the most delicate arrangement of apparatus, to make you, or myself, sensible that these balls did attract one another; and yet we know that such is the case; because if, instead of taking a small ivory ball, we take a mountain, and put a ball like this near it, we find that, owing to the vast size of the mountain as compared with the billiard-ball, the latter is drawn slightly towards it; showing clearly that an attraction *does* exist, just as it did between the shellac which I rubbed and the piece of paper which was overturned by it.

Now, it is not very easy to make these things quite clear at the outset, and I must take care that I do not leave anything unexplained as I proceed, and, therefore, I must make you clearly understand that all bodies are attracted to the earth, or, to use a more learned term, *gravitate.* You will not mind my using this word, for when I say that this penny piece *gravitates*, I mean nothing more nor less than that it falls towards the earth, and if not intercepted, it would go on falling, falling, until it arrived at what we call the *centre of gravity* of the earth, which I will explain to you by-and-by.

I want you, now, to understand that this property of gravitation is never lost, that every substance possesses it, that there is never any change in the quantity of it; and, first of all, I will take as illustration a piece of marble. Now this marble has weight—as you will see if I put it in these scales; it weighs the balance down, and if I take it off, the balance goes back again and resumes its equilibrium. Now I can decompose this marble and change it, in the same manner as I can change ice into water and water into steam. I can convert a part of it into *its own* steam easily, and show you that this steam from the marble has the property of remaining in the same place at common temperatures, which *water*-steam has not. If I add a little liquid to the marble and decompose it, I get that which you see—[the Lecturer here put several lumps of marble into a glass jar, and poured water and then acid over them; the carbonic acid immediately commenced to escape with considerable effervescence]—the appearance of boiling, which is only the separation of one part of the marble from another. Now this [marble] steam, and that [water] steam, and all other steams *gravitate* just like any other substance does; they are all attracted the one towards the other, and all fall towards the earth, and what I want you to see is that *this* steam gravitates. I have here (Fig. 2) a large vessel placed upon a balance, and the moment I pour

Fig. 2.



this steam into it you see that the steam gravitates. Just watch the index and see whether it tilts over or not. [The Lecturer here poured the carbonic acid out of the glass in which it was being generated into the vessel suspended on the balance, when the gravitation was at once apparent.] Look how it is going down. How pretty that is! I poured nothing in but the invisible steam, or vapor, or gas which came from the marble, but you see that part of the marble, although it has taken the shape of air, still gravitates as it did before. Now, will it weigh

down that bit of paper? [Placing a piece of paper in the opposite scale.] Yes, more than that; it nearly weighs down this bit of paper. [Placing another piece of paper in.] So that you now see that *other* forms of matter besides solids and liquids tend to fall to the earth; and, therefore, you will now accept from me the fact that *all* things gravitate, whatever may be their form or condition. Now *here* is another chemical test which is very rapid. [Some of the carbonic acid was poured from one vessel into another, and its presence in the latter shown by introducing into it a lighted taper, which was immediately extinguished.] You see from this also that it gravitates. All these experiments show you that, tried by the balance, tried by pouring it like water from one vessel to another, this steam, or vapor, or gas, is attracted to the earth just like other things.

Now there is another point that I want to draw your attention to. I have here a quantity of shot; each one of these falls separately, and each has its own gravitating power, as you perceive when I let them fall loosely on a sheet of paper. Now if I put them into a bottle I collect them together as one mass, and philosophers have discovered that there is a certain point in the middle of the whole collection of shots that may be considered as the *one point* in which all their gravitating power is centred, and that point they call the *centre of gravity;* it is not at all a bad name, and rather a short one—the centre of gravity. Now suppose I take a sheet of pasteboard, or any other thing easily dealt with, and suppose I run a bradawl through it at one corner A (Fig. 3), and Mr. Anderson holds that up in his hand before us, and I then take a piece of thread and an ivory ball, and hang that upon the awl, then the centre of gravity of both the pasteboard and the ball and string are as near as they can get to the centre of the earth; that is to say, the whole of the attracting power of the earth is, as it

Fig. 3.

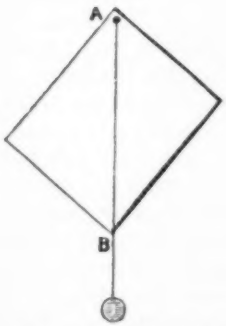
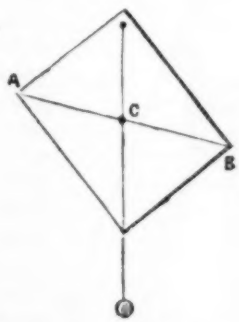


Fig. 4.



were, centred in a single point of the cardboard; and this point is exactly below the point of suspension. All I have to do, therefore, is to draw a line A B, corresponding with the string, and we shall find that the centre of gravity is somewhere in that line. But where? To find that out all we have to do is to take another place for the awl (Fig. 4), hang the plumb-line, and make the same experiment, and

there [at the point c] is the centre of gravity—there where the two lines which I have traced cross each other; and if I take that pasteboard, and make a hole with the bradawl through it at that point, you will see that it will be supported in any position in which it may be placed. Now, knowing that, what do I do when I try to stand upon one leg? Do you not see that I push myself over to the left side, and quietly take up the right leg, and thus bring some central point in my body over this left leg? What is that point which I throw over? You will know at once that it is the *centre of gravity*—that point in me in which the whole gravitating force of my body is centred, and which I thus bring in a line over my foot.

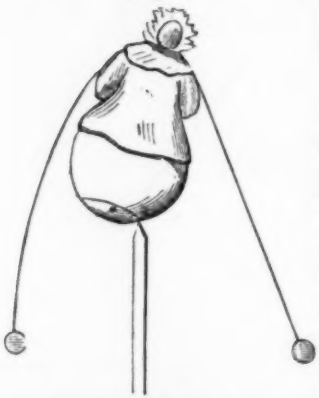
Now I have here a toy, which I happened to see the other day, and I think it will serve to illustrate our subject very well. That toy ought to lie something in this manner (Fig. 5). And it would do so if it were

Fig. 5.

Fig. 6.

uniform in substance; but you see it does not, it will get up again. And now philosophy comes to our aid; and I am perfectly sure, without looking inside the figure, that there is some arrangement there by which the centre of gravity is at the lowest point when the image is standing upright; and we may be certain when I am tilting it over (Fig. 6) that I am lifting up the centre of gravity, and raising it from the earth. All this is effected by putting a piece of lead inside the lower part of the image, and making the base of the large curvature, and there you have the whole secret. But what will happen if I try to make the figure stand upon a sharp point? You observe that I must get that point *exactly* under the centre of gravity or it will fall over thus [endeavoring unsuccessfully to balance it]; and this you see is a difficult matter, I cannot make it stand steadily; but if I embarrass this poor old lady with a world of trouble, and hang this wire with bullets at each end about her neck, you see that it is very evident that owing to there being those two balls of lead hanging down on each side, in addition to the lead inside, I have lowered the centre of gravity, and now she will stand upon this point

Fig. 7.



(Fig. 7); and, what is more, she proves the truth of our philosophy by standing sideways.

I remember an experiment which puzzled me very much when a boy. I read it in a conjuring book, and this was how the problem was put to us: "How," as the book said, "how to hang a pail of water, by means of a stick, upon the side of a table." Now I have here a table, a piece of stick, and a pail, (Fig. 8,) and the proposition is, how can that pail be hung to the edge of this table? It is to be done, and can you anticipate what arrangement I shall make to enable me to succeed?

Fig. 8.

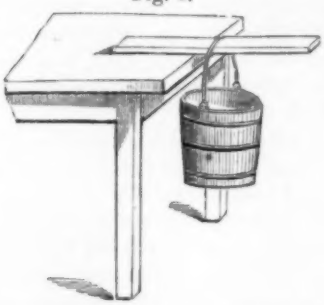
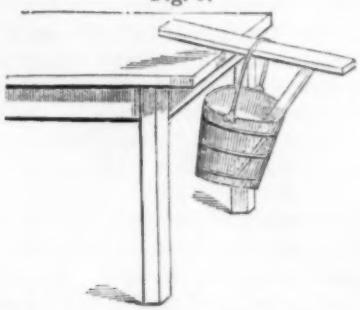


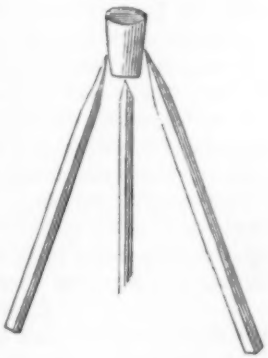
Fig. 9.



Why this. I take a stick, and put it in the pail between the bottom and the horizontal piece of wood, and thus give it a stiff handle, and there it is; and what is more, the more water I put into the pail, the better it will hang. It is very true that before I quite succeeded I had the misfortune to push the bottoms of several pails out; but here it is hanging firmly (Fig. 9), and you now see how you can hang up the pail in the way which the conjuring books require.

Again, if you are really so inclined (and I do hope all of you are), you will find a great deal of philosophy in this [holding up a cork and a pointed thin stick about a foot long]. Do not refer to your toy-books and say you have seen that before. Answer me rather, if I ask you, have you *understood* it before. It is an experiment which used to seem very wonderful to me when I was a boy; I used to take a piece of cork (and I remember I thought at first that it was very important that it should be cut out in the shape of a man, but by degrees I got rid of that idea), and the problem was to balance it on the point of a stick. Why, you see I only have to stick two sharp pointed sticks on each side, and give it wings, thus, and there you will find this beautiful condition fulfilled.

Fig. 10.



I want now to bring you to another point—all bodies, whether heavy or light, fall to the earth by this force which we call gravity. By observation moreover we see that bodies do not occupy the same time

in falling: I think you will be able to see that this piece of paper and that ivory ball fall with different velocities to the table [dropping them]; and if again I take a feather and an ivory ball, and let them fall, you see they reach the table or earth at different times; that is to say, the ball falls faster than the feather. Now that should not be so, for all bodies do fall equally fast to the earth. There are one or two beautiful points included in that statement. First of all it is manifest that an ounce, or a pound, or a ton, or a thousand tons, all fall equally fast, no one faster than another; here are two balls of lead, a very light one and a very heavy one, and you perceive they both fall to the earth in the same time. Now if I were to put into a little bag a number of these balls sufficient to make up a bulk equal to the large one, they would also fall in the same time; for if an avalanche falls, the rocks and mountains, snow and ice, together falling towards the earth, fall with the same velocity, whatever be their size.

I cannot take a better illustration of this than that of gold leaf, because it brings before us the reason of this apparent difference in the time of the fall. Here is a piece of gold leaf. Now if I take a lump of gold and this gold leaf, and let them fall through the air together, you see that the lump of gold—the sovereign, or coin—will fall much faster than the gold leaf. But why? They are both gold, whether sovereign or gold leaf. Why should they not fall to the earth with the same quickness? *They would do so*, but the air around our globe interferes very much where we have the piece of gold so extended and enlarged as to offer much obstruction on falling through it. I will, however, show you that gold leaf *does* fall as fast when the resistance of the air is excluded—for if I take a piece of gold leaf and hang it in the centre of a bottle, so that the gold, and the bottle and the air within, shall all have an equal chance of falling, then the gold leaf will fall as fast as anything else. And if I suspend the bottle containing the gold leaf to a string, and set it oscillating like a pendulum, I may make it vibrate as hard as I please, and the gold leaf will not be disturbed, but will swing as steadily as a piece of iron would do; and I might even swing it around my head with any degree of force and it would remain undisturbed. Or, I can try another kind of experiment:—if I raise the gold leaf in this way [pulling the bottle up to the ceiling of the theatre by means of a cord and pulley, and then suddenly letting it fall to within a few inches of the lecture table], and allow it then to fall from the ceiling downwards (I will put something beneath to catch it supposing I should be *maladroit*), you will perceive that the gold leaf is not in the least disturbed. The resistance of the air having been avoided, the glass bottle and gold leaf all fall in exactly the same time.

Here is another illustration:—I have hung a piece of gold leaf in the upper part of this long glass vessel, and I have the means, by a little arrangement at the top, of letting the gold leaf loose. Before we let it loose we will remove the air by means of an air pump, and while that is being done let me show you another experiment of the same kind. Take a penny piece, or a half-crown, and a round piece of paper a trifle smaller in diameter than the coin, and try them side

by side to see whether they fall at the same time [dropping them.] You see they do not—the penny piece goes down first. But, now place this paper flat on the top of the coin, so that it shall not meet with any resistance from the air, and upon *then* dropping them you see they *do* both fall in the same time [exhibiting the effect]. I dare say if I were to put this piece of gold leaf, instead of the paper, on the coin it would do as well. It is very difficult to lay the gold leaf so flat that the air shall not get under it and lift it up in falling, and I am very doubtful as to the success of this, because the gold leaf is puckery; but I will risk the experiment. There they go together! [letting them fall,] and you see at once that they both reach the table at the same moment.

We have now the air pumped out of the vessel, and you will perceive that the gold leaf will fall as quickly in this vacuum as the coin does in the air. I am now going to let it loose, and you must be quick to see how rapidly it falls. There! [letting the gold loose,] there it is, falling as gold should fall.

I am sorry to see our time for parting is drawing so near. As I proceed I mean to put upon the board behind me certain words so as to recall to your minds what we have already examined; and I put the word FORCES above all, and I will then add beneath the names of the special forces in the order in which we consider them; and although I fear that I have not sufficiently pointed out to you the more important circumstances connected with this force of GRAVITATION, especially the law which governs its attraction (for which, I think, I must take up a little time at our next meeting), still I will put that word on the board, and I hope you will now remember that we have in some degree considered the *force of gravitation*—that force which causes all bodies to attract each other when they are at sensible distances apart, and tends to draw them together.

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*Boiler Explosion on the South Devon Railway.**

At the adjourned inquest the following interesting and valuable evidence was given by Capt. Tyler, the government inspector, who said he had examined the engine and the pieces. She began to run in December, 1853, and having run 62,136 miles was retubed in October, 1854. She had had no material repairs since that date. She was a goods engine, with two safety valves, each four inches in diameter, which he considered to be sufficient. The outer shell of her fire-box consisted of three plates, each 6 ft. by 9 ft. 4½ inches by $\frac{7}{16}$ inches thick, the dome being on the top of the centre plate. On Saturday, the 10th, she was slightly repaired. She weighed 35 tons, and had run 12,232¾ miles since she was retubed. When she exploded, three portions of the outer shell of the fire-box flew off, besides some smaller pieces, one of these 4 feet by 13½ inches blew to the left through the side of the shed; a second 4 feet 6 inches by 3 feet six inches fell in the permanent way about 15 feet to the right of the engine, and the third 4 feet 3 inches by 2 feet blew against a wall a distance of 30 yards. A whistle was picked up 330 yards, and a lever 230 yards

* From Herapath's Railway Journal, No. 1086.

from the engine. The portion of the boiler which flew to the left was divided from the other portions just above the line of the seam of rivets, and, therefore, he particularly examined this seam. He found the rivets still in their places. The plate was originally $\frac{7}{16}$ of an inch, but was eaten through in a line regularly from $\frac{3}{16}$ to $\frac{5}{16}$ of an inch, leaving only a very small portion of the metal still holding before the explosion. There was a similar seam on the right of the fire-box which appeared likely to have been eaten away in a similar manner to the portion which had given way on the left. Mr. Wright had this seam broken apart, and he now produced it so that it would afford the jury a better idea of his meaning. This effect had been produced upon the boiler by various causes. In the first place the boiler had evidently been injured during its construction by the application of the caulking tool in caulking the edge of the plate; the surface of all the plates of the boiler that he had been able to see had been more or less injured. He explained that the caulker, which is a kind of cutter, had in the use of it made a kind of cut, and this wound being produced corrosion had taken place. The corroded surface was interfered with by the mechanical working of the boiler, arising from internal pressure, as well as the expansion and contraction due to differences of temperature, and this effect was increased when bad water was used. He found that the Company had great difficulty in getting good water at Newton, up to November, 1858, and the salt water taken from the river was used with this engine twice a-day up to that date. It was partly on this account, no doubt, that the corrosive action to which he had referred had proceeded to so great an extent on so young an engine. There were no means of examining the interior of the fire-box, to detect a flaw of this description, without taking the boiler to pieces or drilling holes in it. There were certain precautions which might be adopted to prevent such accidents for the future. First, by taking additional care to see that the caulking was performed without injury to the boiler; secondly, by the use of good water; thirdly, by the use of additional stays, which would tend to prevent the explosion as well as check the mechanical action referred to; and, fourthly, by testing the boiler periodically by hydraulic pressure, up to, say 50 per cent. beyond the ordinary working pressure of the engine. The valves of this engine were set to a working pressure of 120 lbs. to the square inch, when the explosion took place. Capt. Tyler stated, in addition, but it was not taken as evidence, that a curious fact had occurred since the accident. An engine at Newton was discovered to be in a similarly defective state from the same causes, but, in consequence of its being stayed more effectually, it had resolved itself into a leak.

The Coroner having briefly summed up,

The Jury found a verdict—"That the deceased had been killed by the accidental bursting of the engine boiler." The Jury expressed their satisfaction at the lucid report of Capt. Tyler, and hoped every publicity would be given it with a view to prevent the recurrence of such an accident in the future. They also thanked Capt. Tyler and the officers of the Railway Company for the facilities they had afforded them.

*On the Manufacture of the Carbon Elements for Bunsen Batteries.**

By JOHN YOUNG, Manager of the Gas Works, Dalkeith.

The advantages attending the use of the Bunsen Battery as a powerful source of electric action has led to its very general adoption, especially in those experiments of a more brilliant character. The peculiar construction of this battery consists in substituting for platinum, carbon of that condition found in the interior of gas retorts. The difficulty of procuring carbon of this sort, and especially of giving it a proper form when obtained, led to the series of experiments and their results which form the subject of this communication.

Hitherto the supply of prepared carbons has almost exclusively been furnished to this country from the Continent; and so far as they have come under my observation they were made from the retort carbon above mentioned. The precariousness of a supply from this source, and the fact of its being dependent for its continuance upon an evil which gas engineers are trying all means to overcome, suggested the propriety of finding some compound, and mode of treating it, which would render us equally independent of foreign aid, and that period in the history of gas-lighting when the engineer has attained his object. During the spring of last year these experiments were entered upon; and for several weeks at first occupied my whole attention, and at brief intervals during the summer were resumed. In the first outset we were entirely guided in our procedure by the information of the composition and treatment of the carbons by Professor Bunsen, as given in several works on electrical science; but whether the material used by me or the mode of treatment differed from that of the Professor we do not know, but the results in our hands were most unsatisfactory indeed. The prescribed composition used by the Professor is "coke and coal in fine powder, heated together in an iron mould, thus forming a mass of solid carbon of the required form. To give greater solidity, they were plunged into a syrup of sugar, afterwards dried, and then submitted to an intense heat in covered vessels." These instructions are apparently plain enough, unencumbered by detail, and would indicate, by their brevity, that the *solid mass of carbon* was so sure of being obtained that more minute instructions were totally unnecessary. In our experiments we employed the finest pieces of Newcastle coke in powder and the finest English caking coal, and followed the recipe with great care. We used (1) cold moulds, afterwards heating them carefully; and (2) red-hot moulds, and packed in the composition in a fused state; and yet the four weeks in which we were so occupied were characterized by one series of failures, during which we had wasted large quantities of sugar, besides less valuable materials, without receiving a single hint that we were proceeding in the right direction; and not until a partially new process was entered upon did hopes arise that we would ever attain our object. The carbon elements so obtained were either loose and friable, or altogether in a state of powder, or so full of cracks and fissures, when an excess of

* From the Lond. Chemical News, No. 12.

coal was used, that in either case they were useless. Some of the best we endeavored to finish; but after repeated soakings in the syrup of sugar, we could with difficulty produce them of sufficient density; and, when attainable, only at such expense as precluded competition in price with those already in the market.

Starting anew, and availing ourselves of the varieties of coke within reach, and trusting to our own observations for guidance, we entered upon a new series of experiments with different kinds of coke, mixed in various proportions, and differently treated. Among failures, we also had hints of success, and from noting the changes by which these favorable hints had been furnished, we were able to proceed under more cheering prospects. The results of these experiments were, that the coke from the Marquis of Lothian's parrot coal, as left in the gas retort, was best. What peculiarity in this coke should make it superior we cannot say, unless it be the small amount of ash that it contains; but when used by us, it was always covered by a peculiar glistening, silvery deposit of carbon from its own gas. The amount of ash in the coke we found to be less than 7 per cent.

After many trials, we obtained the best results from the following mixture and mode of treatment—viz: 64 per cent. by weight of coke powder, and 36 per cent. of English caking coal in powder, well mixed, and moistened with a solution of sugar or starch, until the mass, when pressed in the hand, retained its form. When starch was used, it was in the form of mucilage; and when syrup of sugar was used, it was composed of one part of sugar to one and a half of water. The prepared composition was pressed very hard into moulds of the required form, and when taken from the mould the cakes were set aside to dry. The use of sugar or starch in the composition is to cause the adhesion of the particles of coke and coal powder, so that they retain the form of the mould, and when dry become a hard cake that can be handled, and closely packed into the coking-mould. The part of the process referred to is conducted precisely the same as in the manufacture of ordinary bricks; but the similarity of manufacture goes no further, as all air has to be excluded from the carbons, otherwise combustion ensues, and entirely destroys them. To prevent the action of the air, the coking is done inside a gas retort, into which a small quantity of coal had been introduced to expel the air. The box or mould in which the bricks were packed during the coking contained thirteen carbons at one time. The length of the box was equal to the thickness of the whole thirteen, including plates of iron of $\frac{1}{8}$-inch thickness, which were placed between them, to prevent the carbons from fusing together.—The breadth of the box was equal to the length of the carbons, and the depth equal to the breadth of the carbons. The mould with cover was so constructed, that the encased carbons should be closely clamped up and compressed between the plates while coking. The great tendency that the caking coal has to tumify while in fusion, by the escape of the gas, made this precaution the more necessary; and unless attended to the carbons would have been loose and porous. The box and its contents were in the retort for about one hour and a half, at a

bright cherry-red heat; and when taken out were covered over with dry dust until cold, to prevent the air from acting on the carbons through the chinks round the cover. When taken from the box the carbons have a close surface, owing to the iron plates compressing the exuding fused coke. At this stage they have no electrical action, and are entirely dependent upon the subsequent parts of the process for the deposit of carbon to bestow this property. From this point in the manufacture, my mode of treatment is new, and depends for the closing of the pores in the coke to the fixed carbon from a soaking of coal tar, and the carbonaceous deposit from gas during its liberation from the coal. My experiments upon sugar, as a source of cementing carbon, showed me that at the best it would be expensive, and exceedingly slow in its action, from the low per centage of fixed carbon that it left. When the syrup used was composed of equal weights of sugar and water, the fixed carbon was only 13 per cent. of the liquid absorbed, or 26 per cent. of the sugar in the solution. At this rate, every ounce weight added to the carbons would cost $1\frac{1}{4}d.$ with sugar at its present cheap rate, besides the additional trouble of having the carbons to dry after each soaking. In using coal tar as a substitute, we first heated it to a temperature of 300°, so as to drive off the naphtha hydro-carbons, which left it in a semi-pitched condition; and while still hot the coke bars were soaked in it till saturated, and sank to the bottom. The per centage of fixed carbon left in the coke after the soaking, and heated to redness, was 32·5 per cent. of the tar absorbed, or $2\frac{1}{2}$ times the weight obtained from sugar, and secured at an infinitely less cost. Pure tar carbon is among the best that I have yet tried for Bunsen Batteries, and it was the success in some experiments that I was making with it that induced me to try it as a source of fixed carbon for the purpose now mentioned.

Three separate soakings in the tar, as described, and as many times heated to a high temperature, are necessary fully to close the pores of the coke. Before the last steeping, the carbons are ground upon a flat stone into the required shape. In grinding, a little water is used, but only so much as may form the abraded powder from the carbons into a pasty state; and as the carbons are still absorbent at this stage, they imbibe the water from the paste, and leave the particles of carbon deposited in the pores on the surface, thereby leaving the close surface shown in the finished state. The carbons are again soaked in tar, and charred at a high temperature, when the process is completed by the final smoothing on a flat stone.

The manufacture of the carbons is conducted simultaneously with the process of gas-making; and thereby, with economy of heat, a considerable amount of carbon is deposited from the gas itself, in addition to the fixed carbon from the tar absorbed. For convenience of having them properly placed upon the coal in the retort, a long semicircular trough of iron is prepared (similar to a water run for eaves of houses) to contain from twelve to twenty at one time, and after the charge of coal is introduced, and before closed up, the long trough and its contents are thrust in over the coals, close up to the roof of the retort,

and allowed to remain till the charge of coal is wrought off—a period of nearly three and a half hours. On being withdrawn, the carbons are scattered about, to cool as rapidly as possible, and prevent their burning away by the action of the air; and when cold they receive the slight rub to smooth them, which finishes the process.

I do not wish it to be understood that I consider these carbon elements have reached their perfect state. This notice only shows the process in a comparatively infant stage; and I hope to be able to prosecute the experiments to greater maturity, so as to be able to place a still better article in the hands of the student of electricity.—*Transactions of the Royal Scottish Society of Arts.*

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*Experiments on the Total Heat of Steam.** By J. P. JOULE, LL.D., F.R.S.—[Read before the Philosophical Society of Manchester.]

The author showed that what is called the total heat of steam, or the quantity liberated when steam is condensed into water of 0° centigrade, consists of—1st, the true heat of evaporation; 2d, the heat due to the work done on the steam during the condensation; and 3d, the heat liberated by cooling the water from the temperature of condensation to the freezing point. The determination of the total heat of steam had been made the object of a very careful and elaborate research by Regnault; but it appeared to the author that independent experiments, conducted in a different and more direct manner, would not be without interest. The following is a summary of the results obtained by him, compared with those of Regnault:

Total pressure of Steam in Inches.	Total Heat in Degrees Centigrade.	
	Author.	Regnault.
37·25	638·43	638·77
57·52	644·77	642·87
111·58	655·45	649·06

On the Conductibility of certain Alloys for Heat and Electricity.† By G. WIEDEMANN.

In an experimental investigation, Wiedemann and Franz‡ found that the thermal and electrical conductibility of metals was nearly identical. Their researches also showed that in brass (which contains 1 part of zinc to 2 of copper) the thermal conductibility differs but very little from that of the worse conducting metal, zinc, although the latter is present in smallest quantity. In other alloys, as those of tin and lead, an analogous relation prevails in reference to the electric conductibility. Messrs. Calvert and Johnson have lately investigated the thermal conductibility of several alloys, and have arrived at results which differ materially from those of Wiedemann and Franz, and which

* From Newton's London Journal, April, 1860.
† From the Lond., Edin., and Dub. Philosophical Mag., March, 1860.
‡ Phil. Mag. [4] vol. vii. p. 33; vol. x. p. 393.

render doubtful the analogy which had been established between the thermal and electrical conductibility. Wiedemann has accordingly determined the conductibility for heat and electricity of several alloys. He used the same method as in the previous researches, and the following Table contains the results at which he has arrived. The standard adopted is silver, the conductibility of which, both for heat and electricity, is taken at 100. Copper zinc $\frac{8}{1}$ denotes an alloy containing 8 parts of copper to one of zinc.

	Conductibility for	
	Heat.	Electricity.
Copper,	73·6	79·3
Copper-Zinc $\frac{8}{1}$,	27·3	25·5
Copper-Zinc $\frac{6\cdot5}{1}$,	29·9	30·9
Copper-Zinc $\frac{4\cdot7}{1}$,	31·1	29·2
Brass $\frac{2\cdot1}{1}$,	25·8	25·4
Zinc,	28·1	27·3
Tin,	15·2	17·0
Tin-Bismuth $\frac{2}{1}$,	10·1	9·0
Tin-Bismuth $\frac{1}{1}$,	5·6	4·4
Tin-Bismuth $\frac{1}{2}$,	2·3	2·0
Rose's Metal,	4·0	3·2

From these results Wiedemann concludes—

1. That the agreement, which had been previously found to exist, between the thermal and electrical conductibility of metals obtains also for alloys.

2. That the conductibilities of alloys of zinc and copper, for heat as well as for electricity, differ but little, even with a considerable excess of copper, from the conductibility of the worse conducting metal, zinc. The alloys of zinc and bismuth, on the contrary, have nearly the mean conductibility calculated from their atomic composition.—Poggendorff's *Annalen*, Nov., 1859.

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*On a Method of Testing the Strength of Steam Boilers.**

By Dr. JOULE.

The author adverted to the means hitherto adopted for testing boilers. 1st. That by steam pressure, which gives no certain indication whether strain has not taken place under its influence, so that a boiler so tested may subsequently explode when worked at the same or even a somewhat less degree of pressure. He trusted that this highly reprehensible practice had been wholly abandoned. 2d, That by hydraulic pressure obtained by a force pump, which does not afford an absolutely reliable proof that the boiler has passed the ordeal without injury, and moreover requires a special apparatus. The plan which had been adopted by the author for two years past, with perfect success, was

* From Newton's London Journal, April, 1860.

free from the objections which applied to the above, and is as follows: The boiler is entirely filled with water; then a brisk fire is made in or under it. When the water has thereby been warmed a little, say to 70° or 90° Fahrenheit, the safety valve is loaded to the pressure up to which the boiler is to be tested. Bourdon's or other pressure indicator is then constantly observed; and if the pressure occasioned by the expansion of the water increases continuously up to the testing pressure, without sudden stoppage or diminution, it may be safely inferred that the boiler has stood it without strain or incipient rupture.

In the trials made by the author, the pressure rose from zero to 62 lbs. on the square inch in five minutes. The facility of proving a boiler by this method was so great, that he trusted that owners would be induced to make those periodical tests, without which, fatal experience had shown that no boiler should be trusted.

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*On Tungsten Steel.** By F. X. Wurm.

Franz Mayr has produced, at his cast steel works at Kapfenberg, in Styria, cast steel of such dimensions, forms, and excellent quality, as could previously only be obtained from Krupp, of Essen. Oblique cog-wheels for coining machines and locomotives, axles for railway carriages, boiler plates, angle knees, and round, flat, and quadrangular rods, of various sections, have now been produced by Mayr for more than a year.

What particularly deserves to be mentioned with regard to these articles, is Mayr's unrivalled tungsten-steel distinguished by the fineness of its crystalline texture and its remarkable hardness, so much so, indeed, that the experiments made with it several months ago have shown that tools made from it for cutting toothed wheels, borers, chisels, punches, turning tools, planing blades, &c., retain their power of cutting four times as long as those made of Hundsman-steel, previously regarded as the best. This steel may therefore be recommended as the best for these purposes.

Tungsten has nearly the same specific gravity as gold, and this density is recognisable in the cast steel alloyed with it, by the alteration in the grain of the fractured surface, and by the heightened ring of the steel.

In hardness, metallic tungsten nearly approaches the hardest of natural bodies, and it communicates this property to cast steel, without injuring its tenacity and malleability when the addition is of 2—5 per cent.

The absolute solidity of tungsten-steel exceeds that of all other known steels, for fifteen consecutive experiments with a machine in the Polytechnic Institute of Vienna showed the highest power of resistance to be 1393 hundredweights, and the lowest 1015 hundredweights, giving an average of $1158\frac{3}{15}$ hundredweights to the square inch; so that this steel exceeds all other kinds hitherto tried.

The ore of tungsten from which the metal is obtained, usually occurs

*From the London Chemical Gazette, No. 403.

in company with tin-stone; it has probably hitherto never obtained any technical application, as it has only been regarded as a mineralogical curiosity.

More recent investigations have shown, however, that the arts may derive considerable benefit from it. One of the richest sources of this ore is possessed by the Austrian empire in the tin mines of Zinnwald in Bohemia, where the tungsten ore has been thrown upon the heaps as worthless for nearly five hundred years.

Mayr has the great merit of having been the first to bring this new and hitherto unemployed metal into use in the manufacture of cast steel on the large scale, having introduced tungstic cast steel into commerce of the most various degrees of hardness, and of any dimensions.

The price of this steel, notwithstanding its remarkable goodness, is lower than that of the English cast steel, over which the uniformity of its crystalline texture gives it a peculiar advantage.

The above properties of density, hardness, and strength, are also communicated by tungsten to cast iron, and this alloy may probably be useful for crushing-rollers, and may perhaps in time attract the attention of the artillery.—Dingler's *Polyt. Journal*, clii, p. 178.

For the Journal of the Franklin Institute.

Particulars of the Steamer Flushing.

Hull built by Samuel Sneden & Co. Machinery by Morgan Iron Works, New York. Designed by T. F. Rowland, Engineer. Owners, New York and College Point and Flushing Steamboat Company. Intended service, New York to Flushing.

Hull.—Length on deck, 161 ft. Do. at load line, 155 ft. Breadth of beam (molded), 27 ft. Depth of hold to spar deck, 8 ft. Frame, L; depth, 3 ins.; width of web, 5-16 in.; width of flanches, 3 ins. Plates, thickness, 5-16 to No. 3. Cross Floors, 12 ins. deep × ½-in., connecting every alternate frame. Keel, depth, 3 ins. Rivets, ⅝-in. diameter; apart, 2½ ins. Bulkheads, 3. Draft when launched, 2 ft. 2 ins. Do. when loaded, 4 ft. Tonnage, 323. Area of immersed section at load draft of 4 ft, 85 sq. ft.

Engines.—Vertical beam. Diameter of cylinder, 36 ins. Length of stroke, 10 ft. Maximum pressure of steam, 50 lbs. Cut-off, 5 ft. Maximum revolutions at above pressure, 27.

Boiler.—One—Return tubular. Length of boiler, 24 ft. Breadth do., furnace, 10 ft., shell, 8 ft. 6 ins. Number of furnaces, two. Breadth do., 4 ft. 6 ins. Length of grate bars, 7 ft. Number of tubes, above, 140. Do. flues, below, 10. Internal diameter of tubes, above, 2¾ ins. Do. flues, below, 6 of 12 ins., 2 of 9 ins., and 2 of 13 ins. Length of tubes, above, 10 ft. Heating surface, 2200 sq. ft. Diameter of smoke-pipes, 3 ft. 6 ins. Height do., 50 ft.

Paddle Wheels.—Diameter over boards, 26 ft. Length of blades, 6 ft. 6 ins. Number of do., 22.

Remarks.—Two box keelsons and four plate keelsons running fore and aft. Iron in hull, 136,000 lbs.

Trial in May, 1859. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Stern-wheel Steamer Vencedor.

Hull built by Samuel Sneden & Co. Machinery by H. Ester & Co., New York. Designed by T. F. Rowland, engineer. Owners, Magdalena Steam Navigation Co. Intended service, Magdalena River.

HULL.—Length on deck, 155 ft. Do. at load line, 150 ft. Breadth of beam (molded), 24 ft. Depth of hold to spar deck, 5 ft. Frame—molded, 6 ins.—sided, 4 ins.—apart from centres, 24 ins. Bulkheads, two. Bottom plank, 2 ft. 5 ins. thick, of yellow pine. Sides, 2 ins. thick, do. do. Decks, white pine, 2 ins. thick. Promenade deck, do., 1 in. thick. Hurricane do., do., ¾-in. do. Draft, forward and aft, loaded, 3 ft. 6 ins. Area of immersed section at load draft of 3 ft. 5 ins., 82 sq. ft.

ENGINES.—Inclined direct. Diameter of cylinder, 16 ins. Length of stroke, 6 ft. Maximum pressure of steam, 120 lbs. Cut-off, variable. Maximum revolutions at above pressure, 35.

BOILER.—One—Locomotive. Length of boiler, 18 ft. 8 ins. Breadth do., 8 ft. 1 in. Height do. exclusive of steam chimney, 7 ft. 6 ins. Number of furnaces, 2. Breadth do., 3 ft. 6 ins. Length of grate bars, 6 ft. Number of tubes, 138. Internal diameter of do., 3 ins. Length of do., 12 ft. Heating surface, 1500 sq. ft. Diameter of smoke-pipes, 3 ft.

PADDLE WHEELS.—Diameter over boards, 16 ft. Length of blades, 17 ft. Depth of do., 15 ins. Number of do., 15. C. H. H.

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*On Light-house Illumination.—The Electric Light.** By Prof. FARADAY, D. C. L., F. R. S.

[Royal Institution of Great Britain.]

The use of light to guide the mariner as he approaches land, or passes through intricate channels, has, with the advance of society and its ever increasing interests, caused such a necessity for means more and more perfect, as to tax to the utmost the powers both of the philosopher and the practical man, in the development of the principles concerned and their efficient application. Formerly the means were simple enough; and if the light of a lantern or torch was not sufficient to point out a position, a fire had to be made in their place. As the system became developed, it soon appeared that power could be obtained, not merely by increasing the light, but by directing the issuing rays; and this was in many cases a more powerful and useful means than enlarging the combustion; leading to the diminution of the volume of the former with, at the same time, an increase in its intensity. Direction was obtained, either by the use of lenses dependent altogether upon refraction, or of reflectors dependent upon metallic reflection. [And some ancient specimens of both were shown.] In modern times the principle of total reflection has also been employed, which involves the use of glass, and depends both upon refraction and reflection. In all these appliances much light is lost; if metal be used for reflection, a certain proportion is absorbed by the face of the metal; if glass be used for refraction, light is lost at all the surfaces where the ray passes between the air and the glass; and also in some degree by absorption in

* From the Lond. Ed. and Dub. Phil. Mag., April, 1860.

the body of the glass itself. There is, of course, no power of actually increasing the whole amount of light, by any optical arrangement associated with it.

The light which issues forth into space must have a certain amount of divergence. The divergence in the vertical direction must be enough to cover the sea from the horizon, to within a certain moderate distance from the shore, so that all ships within that distance may have a view of their luminous guide. If it have less, it may escape observation where it ought to be seen; if it have more, light is thrown away which ought to be directed within the useful degree of divergence; or, if the horizontal divergence be considered, it may be necessary so to construct the optical apparatus, that the light within an angle of 60° or 45° shall be compressed into a beam diverging only 15°, that it may give in the distance a bright flash having a certain duration instead of a continuous light,—or into one diverging only 5° or 6°, which, though of far shorter duration, has greatly increased intensity and penetrating power in hazy weather. The amount of divergence depends in a large degree upon the bulk of the source of light, and cannot be made less than a certain amount, with a flame of a given size. If the flame of an Argand lamp, $\frac{7}{8}$ of an inch wide and $1\frac{1}{2}$ inch high, be placed in the focus of an ordinary Trinity House parabolic reflector, it will supply a beam having about 15° divergence; if we wish to increase the effect of brightness, we cannot properly do it by enlarging the lamp flame; for though lamps are made for the dioptric arrangement of Fresnel, which have as many as four wicks, flames $3\frac{1}{2}$ inches wide, and burn like intense furnaces, yet if one be put into the lamp place of the reflector referred to, its effect would chiefly be to give a beam of wider divergence; and if to correct this, the reflector were made with a greater focal distance, then it must be altogether of a much larger size. The same general result occurs with the dioptric apparatus; and here, where the four-wicked lamps are used, they are placed at times nearly 40 inches distant from the lens, occasioning the necessity of a very large, though very fine, glass apparatus.

On the other hand, if the light could be compressed, the necessity for such large apparatus would cease, and it might be reduced from the size of a room to the size of a hat; and here it is that we seek in the electric spark, and such like concentrated sources of light, for aid in illumination. It is very true, that by adding lamp to lamp, each with its reflector, upon one face or direction, power can be gained; and in some of the revolving lights, ten lamps and reflectors unite to give the required flash. But then not more than three of these faces can be placed in the whole circle; and if a fixed light be required in all directions round the light-house, nothing better has been yet established than the four-wicked Fresnel lamp in the centre of its dioptric and catadioptric apparatus. Now the electric light can be raised up easily to an equality with the oil lamp, and if then substituted for the latter, will give all the effect of the latter; or by expenditure of money it can be raised to a five or tenfold power, or more, and will then give five or tenfold effect. This can be done, not merely without increase of the volume

of the light, but whilst the light shall have a volume scarcely the 2000th part of that of the oil flame. Hence the extraordinary assistance we may expect to obtain by diminishing the size, and perfecting the optical part of the apparatus.

Many compressed intense lights have been submitted to the Trinity House; and that corporation has shown its great desire to advance all such objects and improve the lighting of the coast, by spending, upon various occasions, much money and much time for this end. It is manifest that the use of a light-house must be never failing, its service ever sure; and that the latter cannot be interfered with by the introduction of any plan, or proposition, or apparatus, which has not been developed to the fullest possible extent, as to the amount of light produced,—the expense of such a light,—the wear and tear of the apparatus employed,—the steadiness of the light for 16 hours,—its liability to extinction,—the amount of necessary night care,—the number of attendants,—the nature of probable accidents,—its fitness for secluded places, and other contingent circumstances, which can as well be ascertained out of a light-house as in it. The electric spark which has been placed in the South Foreland, High Light, by Prof. Holmes, to do duty for the six winter months, had to go through all this preparatory education before it could be allowed this practical trial. It is not obtained from frictional electricity, or from voltaic electricity, but from magnetic action. The first spark (and even magnetic electricity as a whole) was obtained twenty-eight years ago. (Faraday, Philosophical Transactions, 1832, p. 32.) If an iron core be surrounded by wire, and then moved in the right direction near the poles of a magnet, a current of electricity passes, or tends to pass, through it. Many powerful magnets are therefore arranged on a wheel, that they may be associated very near to another wheel, on which are fixed many helices with their cores like that described. Again, a third wheel consists of magnets arranged like the first; next to this is another wheel of the helices, and next to this again a fifth wheel carrying magnets. All the magnet-wheels are fixed to one axle, and all the helix wheels are held immovable in their place. The wires of the helices are conjoined and connected with a commutator, which, as the magnet-wheels are moved round, gathers the various electric currents produced in the helices, and sends them up through two insulated wires in one common stream of electricity into the light-house lantern. So it will be seen that nothing more is required to produce the electricity than to revolve the magnet-wheels. There are two magneto-electric machines at the South Foreland, each being put in motion by a two horse power steam engine; and, excepting wear and tear, the whole consumption of material to produce the light is the coke and water required to raise steam for the engines and carbon points for the lamp in the lantern.

The lamp is a delicate arrangement of machinery, holding the two carbons between which the electric light exists, and regulating their adjustment; so that whilst they gradually consume away, the place of the light shall not be altered. The electric wires end in the two bars of a small railway; and upon these the lamp stands. When the carbons of a lamp are nearly gone, the lamp is lifted off and another

instantly pushed into its place. The machines and lamp have done their duty during the past six months in a real and practical manner. The light has never gone out through any deficiency or cause in the engine and machine house; and when it has become extinguished in the lantern, a single touch of the keeper's hand has set it shining as bright as ever. The light shone up and down the Channel, and across into France, with a power far surpassing that of any other fixed light within sight, or anywhere existent. The experiment has been a good one. There is still the matter of expense and some other circumstances to be considered; but it is the hope and desire of the Trinity House, and all interested in the subject, that it should ultimately justify its full adoption.

For the Journal of the Franklin Institute.

Particulars of the Steamer Daniel Drew.

Hull built by Thomas Colyer. Machinery by Neptune Iron Works, New York. Owners, Daniel Drew and others.

Hull.—Length on deck, 251 ft. 8 ins. Do. at load line, 244 ft. Breadth of beam (molded), 30 ft. 6 ins. Depth of hold to spar deck, 9 ft. 3 ins. Frames—molded, 15¾ ins.—sided, 4 ins.—apart from centres, 30 ins. Keel, depth, 3 ins. Draft, forward and aft, 4 ft. 6 ins.

Engine.—Vertical beam. Diameter of cylinder, 60 ins. Length of stroke, 10 ft. Maximum pressure of steam, 35 lbs. Cut-off, one-half. Maximum revolutions at above pressure, 26.

Boilers.—Two—Return flued. Length of boilers, 29 ft. Breadth do., at furnace, 9 ft., at shell, 8 ft. Height do., exclusive of steam chimney, 9 ft. 4 ins. Number of furnaces, two. Length of grate bars, 7 ft. Number of flues, above, 14; below, 10. Internal diameter of do., above, 9½ ins. Do. do., below, 2 of 13½ ins., 1 each of 13, 11, and 7½ ins. Length of do., above, 22 ft. Heating surface, 3350 sq. ft. Diameter of smoke-pipes, 4 ft. Height do., 32 ft.

Paddle Wheels.—Diameter over boards, 29 ft. Length of blades, 9 ft. Depth of do., 26 ins. Number of do., 24.

Remarks.—One independent steam, fire, and bilge pump.

This steamer has been built to attain a very high speed, having a very easy and a very superior model. The velocity of the periphery of her water-wheel blades is 27 miles an hour.

Date of trial, May, 1860. C. H. H

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*British Modular Standard of Length.** By J. F. W. Herschel.

It may not be unwelcome to the scientific portion of your readers to have their attention directed to a simple numerical relation between our actual parliamentary standard of length and the dimensions of the earth, which, in effect, puts us in easy possession of a "modular" system, which might be decimalized, and which, abstractedly considered,

* From the Lond. Athenæum, April, 1860.

is far more scientific in its origin, and, numerically, very far more accurate than the boasted metrical system of our French neighbors. It is simply this,—if the British Imperial standard inch were increased by one-thousandth part it would be, with all but mathematical precision, one five-hundred-millionth part of the earth's axis of rotation.

The calculations of the present Astronomer Royal, published in the year 1830, have determined the length of this axis at 41,707,620 feet, that is to say, 500,491,440 inches of our Imperial standard. Those of Bessel, published in 1841, at 500,487,744 such inches. More recently an elaborate *résumé* of the whole subject, by M. Schubert, has conducted him to three separate and independent conclusions, based on arcs measured each in, or near, a meridian appropriate to the country in which they have been performed, viz: the Russian, the British Indian, and the French arcs. The Russian and the Indian combinations give respectively 500,532,120 and 500,550,168, while the French arc gives only 500,368,920. M. Schubert rejects the latter altogether; but the propriety of doing so appears to Mr. Airy questionable on grounds which we consider so far reasonable as to entitle it to at least half the weight of either of the former. On the other hand, M. Schubert, in computing his mean result, assigns to the Russian result double the weight of the Indian,—a decision in which I can by no means acquiesce. Allowing to each of the former the weight 2, and to the latter 1, the final conclusion from this calculation is 500,506,699; and from the mean of Airy, Bessel, and Schubert, 500,495,294, which differs from 500,500,000 by *less than its hundred-and-six-thousandth part.* This then is the fractional error of our "modular" unit in proportion to its own length of 1·001 British standard inch, or that of a "module" of 50·05 such inches, which, in this view of the subject, might be taken for the British unit of linear measure, or one ten-millionth of the earth's axis. The Astronomer Royal, in discussing these computations of M. Schubert (vol. xx, *Notices of the Royal Astron. Soc.* p. 105), insists, very properly, on the individuality of the polar diameter of the earth as compared with its equatorial diameters, which differ materially in different meridians (having regard to an imaginary sea-level, and independently of the heights of mountains or continents). If any axis be chosen for a scientific unit it should assuredly be the polar axis. The nature of things gives this an absolute, indefeasible preference to every other, not excepting even that of the equator in the meridian of Paris itself.

Every geometer will agree that the radius of a circle is a more fundamental or primary parameter, or unit of linear dimensions, than its circumference. To beings of other psychological constitution than man, it may be otherwise; but take the genus *homo* and the species *geometer* as they stand, this is a fact. *A fortiori*, the axis, major or minor, of an ellipse is a more primary and fundamental unit of its dimensions than its periphery, leaving the question as to *which* axis, major or minor, to be decided on its own grounds.

The French métre is assumed to be the ten-millionth part of the quadrant of the earth's elliptic meridian passing through Paris. Its

value is authoritatively stated in the Annuary of the French Board of Longitude at 39·37079 British Imperial standard inches; and, therefore, in reference to the natural unit in which it originates, is erroneous by one part in 8400 of its proper length, that is to say, between 12 and 13 times more in proportion than our proposed module.

The adoption of such a "British Modular System" of measure requires no Act of Parliament. It is so easy to convert "Imperial standard" lengths, of whatever denomination, into "British modular" lengths of the same denomination by subtracting (or modular into imperial by adding) one-thousandth, that it is not worth while to legislate on the subject, so far as measures of length are concerned. The difference between one part in 1000 and one in 999, in the conversion and re-conversion, being only one in 999,000, is of no importance whatever. Nor is it worth while to change our ordinary parlance. 1 foot or 1 yard, in 1000, is a difference telling as nothing in any practical contract for work on a great scale. On a small one it is quite inappreciable. The scientific man only is interested in it; and it suffices him to know (and the knowledge, to him, is important) that he can refer all his measurements to the best unit nature affords, by subtracting a thousandth (that is, by writing his figures twice over, in two lines, one under the other, shifting the lower three figures to the right, and executing a subtraction sum) far better than by referring to the *Annuaires des Bureaux* of metricized countries, and performing a calculation of greater complexity, landing him in twelve or thirteen times the amount of error. Of course, I am not speaking of a system of *decimalization*. To decimalize our measures we must reduce them to "modular inches," or to "modules" of 50 such inches; but we may speak of modular miles, yards, feet, or inches with reference to a modular unit, while retaining the associations of our actual metrical system. A similar remark applies to the Russian metrical system, which is based upon the English—the fundamental unit being the *Sagene* of 7 British feet.

I ought, in fairness, to mention that my attention was drawn in the first instance to this *rapprochement* by the statement, over and over again repeated in Mr. Taylor's recent work, entitled "The Great Pyramid, Why was it Built? &c." (Longman, 1859) (pp. 35, 36, 67, 87, 280, 298, &c.,) that the diameter of the earth in the latitude of the Pyramid is 41,666,667 English feet, or 500,000,000 of English inches; which it is not: and it is singular that the reduction of Mr. Airy's polar axis from feet to inches, in page 87, which is rightly performed, does not appear to have suggested the least misgiving as to the correctness of the statement, or (which is more to our present purpose) led him to notice the important practical facility of reduction from the parliamentary to the modular standard above insisted on. It is not my object here to criticize the work in question, which, in the midst of much confusion and no small amount of error, contains some valuable and (so far as we are aware) original remarks. Of these I may mention the conclusion its author has drawn from the angle of slope of the casing-stones discovered by Col. Vyse, that the builders of the Pyra-

mid were acquainted with the ratio of the circumference of a circle to its diameter—a piece of knowledge they were desirous to embody in its dimensions. In fact, the slope of the original faces of the Pyramid comes out from Vyse's (or Perring's) measurement of the linear dimensions of these stones, 51° 52′ 15½″, and by Brettel's measure of their angle, 51° 50′ 0″, the mean of which differs *only by a single second* from the angle whose cotangent is the length of an arc of 45° of the circle, so as to make the whole periphery of the base all but mathematically equal to the circumference of a circle described with the height for a radius. So stated, the coincidence is certainly very striking. It by no means follows, however, that the ancient Egyptians were in possession of any *calculus* by which they could have arrived at a theoretical knowledge of the true ratio. It should be observed that the linear measures above mentioned are given only to entire inches, and those, inches of a scale which may or may not have been verified with extreme precision, and therefore can lay no claim to minute accuracy. Computing, moreover, on these measures alone, the ratio of the periphery to the height comes out 6·2784, while that resulting from the direct measure of the angle is 6·2878, the true ratio being 6·2832. The individual results differ by one 640th part of the whole quantity, and as we do not know with what instruments or what precautions the angle was measured, and it is given only to the nearest minute, it seems but reasonable to admit an equal proportional latitude of uncertainty in the original workmanship and in the numerical relation to which it was intended to conform. Now this is a very considerable approximation, much better than that of Archimedes a thousand years later. Still, it would be easy for people in possession of such appliances as they must have had at command, to ascertain the ratio in question to this, or even to a greater degree of precision, by tracing, for instance, on a flat pavement a circle of 100 feet in diameter and actually measuring the circumference. This they certainly might have done to the nearest half-foot, which, on a length of 314 feet, would correspond to such a latitude of error. If aware of the importance of the problem, they might have gone much further.

But, again, it by no means follows, from any thing which the dimensions of the Pyramid indicate, that they did possess a knowledge of the ratio of the circumference of a circle to its diameter, even approximately. By a very remarkable coincidence, which Mr. Taylor has the merit of having pointed out, the same slope, or one practically undistinguishable from it (51° 49′ 46″), belongs to a pyramid characterized by the property of having each of its faces equal to the square described upon its height. This is the characteristic relation which, Herodotus distinctly tells us, it was the intention of its builders that it should embody, and which we now know it did embody, in a manner quite as creditable to their workmanship as the solution of such a problem was to their geometry. This problem, however, has no relation to that of the rectification of the circle. The coincidence is one as purely accidental as any thing relating to abstract number can be; and although in solving the one problem which we know they did intend,

they at the same time, practically speaking, resolved another which stands in no rational connexion with it, or any connexion beyond that of happening to have, very approximately, the same numerical solution, —we are not entitled to conclude that they were aware of this coincidence, and intended to embody *both* results in their building.

Another curious and novel relation, for pointing out which we are indebted to Mr. Taylor, is one ("Great Pyramid," page 37) which may be most intelligibly expressed under the following form of announcement, viz:—that a belt, encircling the globe, of the breadth of the base of the Great Pyramid, would contain one hundred thousand millions of square feet.* If the feet be Imperial Standard, and the belt Equatorial, this is approximate only to one part in 288 of the whole. But if we suppose the belt meridional, and the area expressed in "modular" square feet, the approximation is within one part in 1100. The fact is interesting as offering the only tolerable approach in round numbers to an arithmetical relation between any of the dimensions of this Pyramid and those of the earth.

* Mr. Taylor has (*in words*) *one hundred millions*, which is a misprint.

Collingwood, April 23, 1860.

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*The Production of Photographic Images on Plates of Glass or Porcelain, by the Action of Light, enabling them to be permanently fixed by being Burnt in with Ceramic Colors.** By JOHN WYARD.

The plates of glass, or porcelain, or other substance, on which the pictures are to be produced, may be glazed prior to the application of the sensitive mixture, or otherwise this glaze or flux may be carried over the finished picture before burning. The first preparation of the plates after cleaning consists in the application of the following sensitive mixture:—

I make separate solutions of gum arabic and gelatine.

Gum Arabic, . .	72 grains.
Sat. Sol. Bichromate of Potass, .	½ oz. by measure.

Dissolve without heat.

Gelatine (Bell's) . .	15 grains.
Water, . .	1 oz. by measure.
Sat. Sol. Bichromate, . .	1 dr. "

Dissolve in a water bath. When cool, add the sol. bichromate.—Shake well and filter.

Take of the solution of—

Gum Arabic, . .	11 parts.
Solution of Gelatine, . . .	5 "
Water Distilled, . .	5 "

To every dram of this mixture add 9 or 10 drops of honey syrup, formed by mixing equal parts in volume of honey and water, and filtering.

* From the Journal of the Society of Arts, No. 385.

This mixture must be heated gently in a water bath, well shaken, and filtered through fine muslin.

The substance on which the picture is to be produced, opal glass, porcelain, ordinary kelp, or plate glass, is slightly warmed by a fire, and a sufficient quantity of the above sensitive mixture poured on, in the same manner as a collodion, drained off, and gradually dried before a fire. The film must be very even. A vigorous positive picture, either from a collodion negative, paper, or albumen, or even an engraving, must be placed in contact with the sensitive surface, and the whole exposed to light—sunlight if possible. The exact amount of exposure is a matter of great importance, from six to ten minutes in good sunshine is in most cases sufficient.

When removed from the light a negative image should be visible, the action of the light darkening and hardening the sensitive layer to a much greater degree when using the above mixture than when using plain gelatine. The sunned parts are harder, and the unsunned softer, than is the case with gelatine alone. The advantage I take of this hardening effect of light on the film of the above will be apparent in the next stage of the process.

I produce a positive image in ceramic color on the plate. This is effected by carrying over the surface of the plate the color in a fine state of division, by means of a pad of cotton wool, well charged with the required color. Its successful application requires some experience. The surface of the plate should be beaten gently and equally, not rubbed. The cotton should occasionally be breathed on, and re-charged with color. The color will be found gradually to adhere to the unsunned parts of the film, and its application should be continued until the picture is considered sufficiently powerful. Almost any amount of vigor may be obtained.

The picture is produced by the parts not exposed to light taking the color, and those portions exposed refusing to take it. The original negative image will now be almost lost to appearance by the superior density of the applied color, forming the positive picture, but there remains in the sensitive coating the changed and unchanged bichromate, which it is necessary to remove.

To effect this I apply alcohol to which has been added dilute acid in the proportion of six drops of the dilute acid to the drachm of alcohol.

The dilute acid contains 5 minims of ordinary nitric acid to the drachm of water. A bath of this may be used, or, if the subject is on a flat surface, the liquid can be poured on. While on the plate evaporation of the alcohol takes place; this would be equivalent to adding too much dilute acid to the alcohol, which would damage the film; therefore, in pouring on and off the liquid, care must be taken to keep up the proportion by adding a little pure alcohol occasionally.

When the brown color of the changed bichromate disappears the acid spirit must be poured off, and pure alcohol poured on and off; this must be repeated once or twice with fresh quantities, it being necessary to remove every trace of the acid and water.

The picture must be dried very rapidly, and is now ready for burn-

ing, provided the recipient has been previously covered with a flux or glaze, if not the flux may be applied over the picture in the following manner. Pour on a solution of Canada balsam in spt. turpentine.—Dry the plate by heat until the turpentine is entirely evaporated.

Prepare the flux, which may consist of borax and glass, or borax, glass, and lead, by grinding it on a slab with water, and drying. Apply this (the flux) equally and evenly, by means of a pad of cotton tied up in very soft and flexible leather.

With respect to the colors used, they are ground on a slab with water, and dried.

The red picture is obtained by peroxide of iron, prepared by calcining the sulphate, and washing the mass with successive lots of boiling water; the dark brown by oxide of manganese.

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*Photo-zincography.** By Colonel Sir HENRY JAMES, R.E., Director of the Ordnance Survey.

In the report of the committee of which Sir R. Murchison was chairman, it is stated that the annual saving effected by my having introduced this (the photographic) method of reducing the Ordnance plans from the larger to the smaller scales, amounted in the year 1858 to £1615. Since then we have so much reduced the cost of the photographs, that the saving which will be effected will amount to £35,000 in the cost of the survey. Up to this period we have exclusively used the paper prepared with nitrate of silver for printing the number of copies required; but we have made experiments with the printing paper prepared with the bichromate of potash, gum, and lamp black, or any other pigment, called the chromo-carbon process of printing.

The action of light on a coating of this composition produces the peculiar effect of rendering it insoluble in water, and consequently when a sheet of paper coated with it is placed in the printing frame under the collodion negative, the outline of the plan is rendered insoluble in water, and remains on the paper when all the remainder of the composition is washed away, and thus we have a "positive" plan in ink of any color which may be required.

In comparing the reduced plans obtained by this process with those obtained by the use of paper prepared with the nitrate of silver, we obtain no advantage whatever, but, on the contrary, the prints are less clear and sharp in their outline.

But by a new mode of treatment of these *chromo-carbon* prints which has been introduced by Capt. A. de C. Scott, R.E., who has charge of this branch of the work, and Lance-Corporal Rider, R.E., who is a good photographer, and also possesses a considerable knowledge of chemistry, we can produce very sharp, clear lines. The ink of the print after being soaked in a saturated solution of caustic potash or soda becomes, so to speak, disintegrated, and is then in a state which enables us at once to rub down the print and transfer the outline to the waxed surface of a copper plate for the engraver. This promises

* From the Lond. Mechanics' Magazine, April, 1860.

to be of great importance to us, as after obtaining the photographed reductions of the maps we have hitherto been obliged to make tracings from them in ink, for the purpose of transferring the plan to the copper, the expense and delay of which will now be saved, whilst we run no risk of any error being made by the draughtsman.

We have also tried a method which is still more valuable and by which the reduced print is in a state to be at once transferred to stone or zinc, from which any number of copies can be taken, as in ordinary lithographic or zincographic printing, or for transfer to the waxed surface of the copper plates. To effect this, the paper after being washed over with the solution of the bichromate of potash and gum, and dried, is placed in the printing frame under the collodion negative, and after exposure to the light, the whole surface is coated over with lithographic ink, and a stream of hot water then poured over it; and as the portion which was exposed to the light is insoluble, whilst the composition in all other parts being soluble is easily washed off, we obtain at once the outline of the map in a state ready for being transferred either to stone, zinc, or copper plate, or we can take the photograph on the zinc at once.

This new method of printing from a negative is extremely simple and inexpensive, and promises to be of great use to us. Sheet 96, of Northumberland, has been transferred to the copper plate from impressions taken from this process, and from the perfect manner in which we are able to transfer the impressions to zinc, we can, if required, print any number of faithful copies of the ancient records of the kingdom, such as "Doomsday Book," the "Pipe Rolls," &c., at a comparatively speaking very trifling cost. I have called this new method Photo-zincography, and anticipate that it will become very generally useful, not only to government, but to the public at large, for producing perfectly accurate copies of documents of any kind.

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*Singular Effect of Lightning.**

At the November Meeting of the Philosophical Society of New South Wales, held in the hall of the Australian Library, a very curious circumstance was brought under the notice of the members present, by Professor Smith, respecting the singular effect of lightning upon a gas-pipe. Alluding to the phenomenon, the Professor says:—

"In his laboratory at the University, recently, he had had a connexion made with the iron pipes brought up from the city; the gas-pipe was laid along the front of the building, below the surface of the ground. The pipe was a cast iron one, three inches in diameter, and the connexion with the laboratory was by a small iron pipe, joining a tin pipe, under the floor. There was also a system of lead water-pipes, following nearly the course of the tin gas-pipe, and terminating underneath the door-way, where the gas-pipe entered the laboratory; at this point, or just inside the door-way, the tin gas-pipe touched the lead

* From the Lond. Jour. of Gas Lighting, &c., No. 191.

water-pipe. On Monday afternoon, he left his gas-holder half full of gas—there was nearly twenty cubic feet in it. The stop-cock, between the outside pipe and the laboratory, was closed, and the junction with the gas-holder left open. On Tuesday morning, he tried to light the gas, but found there was none. On going round to ascertain the cause, he found that his gas-holder was empty, though all the stopcocks were shut; and then, on opening the outside stop-cock, he found that there was no pressure on the pressure-gauge, but he soon observed that the room was getting full of gas, from which he inferred that there must be somewhere in the pipe a hole as large as its diameter; otherwise, there would have been some pressure on the gauge. It then occurred to him that this accident might be connected with the fact that, on Monday afternoon, November 14, the University had been struck by lightning; in one of the shears on the tower a deep groove, an inch wide, had been cut out, and there was a terrific crash, suggesting to those in the building the idea that the roof had fallen in. There was a lightning conductor attached to a chimney of the laboratory, and this entered the ground eighteen feet from the gas-pipe, terminating six feet below the surface, in a large copper plate. On sending for the plumber who laid the pipes, he suggested that a rat had gnawn through the pipe on finding it obstructing his way; but, on taking up the flooring, they discovered that the accident must have been due to lightning. On the one side of the pipe, where it had touched the lead water-pipe, was an irregular oval aperture, about an inch long and half an inch wide, and right opposite, on the other side of the pipe, was a smaller rounded aperture, measuring half an inch by three-eighths, the tin being thinned away as if it had been beaten out. A lump of melted tin, weighing 45 grains, lay before the orifice. What had happened was tolerably clear. One of the pipes had been conveying a very powerful charge of electricity, and, coming to the point where it touched the other, the electricity preferred changing its route, and in leaping from the one to the other, it made two great holes. He observed that there was an indent in the lead water-pipe, and a piece of the lead melted. It was a puzzling thing to account for the hole at the back of the pipe. The corner of a brick touched it at that part, and the aperture there had quite a different appearance from that on the other side, the edge on one side (next the brick) being thin and sharp, while on the other it was thickened and melted. The blackening inside the pipe could be accounted for by the gas being decomposed by the electricity. There were many curious points connected with this case. In the first place, where did the lightning come from? He could scarcely imagine that the discharge could have come from the tower, and run along the pipe, which was buried in the ground for nearly two hundred feet. It seemed more probable that the discharge was delivered by the laboratory conductor, and had then passed through the ground to the gas-pipe, though that was eighteen feet away. He thought it might have come along the gas-pipe first, and then taken to the water-pipe as a better conductor. There was still another supposition, however; and, perhaps, the most probable one.

The lightning might have struck the south-east corner of the laboratory, and, being conducted by the lead gutter to the lead cistern under the roof, and thence down the water-pipe to the laboratory, making its exit by the gas-pipe. If this supposition be correct, it shows how limited was the protective power of the lightning conductor attached to a neighboring chimney. The man at the turnpike saw the lightning strike the University; he described it not as a flash of light, but as a ball of fire, which came down in front of the building. It was remarkable that the gas was not ignited by the electricity, and the laboratory set on fire."

A conversation ensued upon the subject, remarks being made upon the action of the lightning as very remarkable, and Professor Smith's explanations were considered fully satisfactory.

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*Decay of Stone.**

SIR:—The cause of the destruction of the stone of the new places at Westminster is undoubtedly the sulphuric acid that is always present in the atmosphere of London, arising from the combustion of coal, which always contains a considerable per centage of sulphur. I noticed this destruction of the stone going on in 1854, when up in London giving evidence before a committee of the House. I then minutely examined the building, and found abundant evidence of decay. My attention was first called to this destructive action of the sulphuric acid in the atmosphere of large towns ten years ago. Having observed a white efflorescence on the bricks and stones of this town [Leeds] wherever there was damp, I analyzed and found it to be sulphate of magnesia and sulphate of lime. I also found sulphuric acid in the air. Combustion of coal is the only source whence so considerable a quantity of acid could be evolved into the air, as all coal contains about one per cent. of sulphur, whose combustion must keep the air of large towns always acid. This acid state of the air is causing serious damage here, as the only lime used is magnesian lime. The sulphate of magnesia formed is dissolved during rain, absorbed into the bricks or stones, and, when dry weather comes, it crystallizes and splits off the face of the bricks or stones like frost.

No magnesian stone or lime should be permitted in large towns, as the acid will act alike on the stone and mortar. The stone of the new palaces is magnesian limestone, and, unless a protection be found, all the mouldings and other parts liable to damp will rapidly decay.

As to the remedy proposed,—an alkaline silicate, or, as it is called, soluble glass,—will, in my opinion, be worse than the disease, as the acid atmosphere will decompose it as easily as the stone. The proper remedy will be to oil the stone with boiled linseed oil, which will prevent it being moist and attracting the sulphuric acid. The oil will not alter the color, and will effectually protect the stone.

C. L. DRESSER, F.C.S.

*** Oiling, in the case of Caen stone, if not of others, is known to have failed.—ED.

* From the Lond. Builder, No. 863.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM APRIL 1, TO APRIL 30, 1860.

Adding Numbers,—Machine for	D. R. Nelson,	Jackson,	Ohio,	24
Air Engines,—Compressed	W. C. Turnbull,	Baltimore,	Md.	17
Alarm Lock,	Joseph Ziegler,	"	"	10
Amalgamators,	I. W. Knox,	San Francisco,	Cal.	24
Artesian Wells,—Boring	John Taney,	Austin,	Texas,	17
Auger,	James Blake,	East Pepperell,	Mass.	17
Axe Handles,—Fastenings for	James E. Emerson,	San Francisco,	Cal.	10
Bank Notes,—Manufacture of	Augustus C. Carey,	Lynn,	Mass.	10
Barrel Heads,—Manufacturing	L. B. Batcheller,	Rochester,	N. Y.	3
Bed Bottom,—Spring	J. Bailey and J. Decamp,	Cincinnati,	Ohio,	3
Bed-cord Tightener,	A. B Stroup,	Waldron,	Ind.	10
Bed,—Spring	John H. Crane,	Charlestown,	Mass.	3
Bee-hives,	Robert Hawkins,	Bealsville,	Penna.	24
Beer Pitcher,	L. Hermance,	Saratoga Spr's,	N. Y.	17
Bells,—Hanging	T. H. Bell,	Washington,	D. C.	17
Belt Fastening,	G. W. Blake,	Pepperell,	Mass.	24
Belting,	Henry Underwood,	City of	N. Y.	10
———,—Making Rubber	Thomas J. Mayall,	Roxbury,	Mass.	3
Bench Planes,	H. C. Hunt,	Ottumwa,	Iowa,	24
—— Vise,	L. A. Beardsly,	S. Edmeston,	N. Y.	24
Boilers for Hot water apparatus,	Edmund B. Cherevoy,	City of	"	10
Bolts,—Heading	Hiram Abbott,	Wakeman,	Ohio,	17
Bonnet Frames,—Manuf. of	R. T. Wilde,	City of	N. Y.	24
Boots and Shoes,—Planes for	E. S. Snell,	N. Bridgewater,	Mass.	10
————,—Heels for	J. V. Dinsmore,	Auburn,	Maine,	3
————,—Overshoes &	McEwen and Patterson,	Kingston,	Tenn.	17
Boxes,—Finishing Wooden	H. A. Jones,	St. Louis,	Mo.	24
——,—Metal Caps for	Deidrich and Slocum,	Philadelphia,	Penna.	3
Bridges,—Truss	G. O. Bishop,	Hannibal	Mo.	24
Brooms,—Metal Head for	H. G. Smith,	Muscatine,	Iowa,	3
Buckles,	John C. Hall,	Fayette,	Miss.	3
Bullet Ladle,	George Rugg,	Potsdam,	N. Y.	24
Burglars Alarm,	George W. Bigelow,	New Haven,	Conn.	10
Butt Hinges,	George H. Fayman,	Washington,	D. C.	10
Candle Machines,—Making	Michael Massey,	Cleveland,	Ohio,	24
Candles,—Moulding	William Thomas,	City of	N. Y.	3
Cane Presses,	Eugene Powell,	Conneautville,	Penna.	10
Caoutchouc,—Vulcanizing	Asahel K. Eaton,	Kings County,	N. Y.	3
———	Charles T. Harris,	N. Brunswick,	N. J.	10
Car Axles,	L. Brown, & J & J Leland,	Worcester,	Mass.	24
— Couplings,	Ruel Rawson,	Quincy,	Mich.	3
Carpenters Clamp,	John Cadwell,	Cincinnati,	Ohio,	24
Carpet Beater and Cleaner,	A. Cutler & E. S. Wright,	City of	N. Y.	10
Carriage Seats,—Sliding	Wm. A. Bird,	Newark,	N. J.	17
——— Springs,	Edward Maynard,	Brooklyn,	N. Y.	3
Cartridge Cases,	George P. Foster,	Providence,	R. I.	10
Cartridges,—Filling Metallic	H. Smith & D. B. Wesson,	Springfield,	Mass.	17
Carving Marble, &c.,	William H. Pease,	Goshen,	Ind.	10
Chair Caster,	Thomas Fry,	Brooklyn,	N. Y.	10
Cheese Presses,	Myron E. Taft,	Potsdam,	"	10
Chucks for cut'g Discs of paper,	Mathaus Kaefer,	City of	"	10
Churn,	Daniel Deshon (2d),	Somerset,	Penna.	3
———	Edward Lynch,	Buffalo,	N. Y.	10
———	S. P. Dunham & A. Hipple,	Kilbourne,	Ohio,	17
———	Jehu Mitchell,	Aleppo towns'p,	Penna.	17
Cigar and Match Cases,	P. J. Clark,	West Meriden,	Conn.	3
Clocks,—Winding Spring of Air	Charles B. Hoard,	Watertown,	N. Y.	3
Clock Weights,—Constructing	Richard F. Bond,	Cambridge,	Mass.	3

Clothes-wringer,	Elliot Dickerman,	Richmond,	Vt.	10
Coal and Ores,—Purification of	Jesse Burroughs,	Ridgway,	Penna.	3
——, &c.,—Buckets for remov'g	J. S. Lloyd,	Salem,	N. J.	24
Combs,	E. M. Noyes,	Newark,	"	24
Coopers' Tool,	J. P. Woods,	Troy,	N. Y.	17
Corn Harvesters,	Adam Humberger,	Somerset,	Ohio,	3
—— Huskers,	N. T. Spear,	City of	N. Y.	10
—— Planters,	G. W. N. Yost,	Yellow Springs,	Ohio,	3
————	Martin A. Howell, Jr.,	Ottawa,	Ill.	10
—— Shellers,	Nathaniel Drake,	Newton,	N. J.	3
—— Shock-binders,	Calvin Stowe,	Braceville,	Ohio,	24
Cotton Thinning Ploughs,	L. B. Joyner,	Hilliardston,	N. C.	24
——— Bales,—Metal Hoops on	John McMurtry,	Fayette Co.,	Ky.	10
——— Seed Planters,	S. P. Sweeney,	Columbia,	Texas,	3
Coupling Attachment for Cords,	J. L. Howard,	Hartford,	Conn.	17
Cradle,—Child's	L. K. Selden,	Haddam,	"	10
——,—Infant's	S. F. Brooks,	Weston,	Mass.	24
Crank,—Overcoming Points of	John P. Cooper,	Finleyville,	Penna.	3
Cultivator Teeth,	Heman B. Hammon,	Bristolville,	Ohio,	10
————	G. C. Aiken,	Nashua,	N. H.	24
Cultivators,	W. B. Dorsay,	Decatur,	Ill.	3
————	John G. Christopher,	Byron,	"	10
————	J. F. Eylar,	Scott,	Ohio,	24
————	I. R. Smith,	Elgin,	Ill.	24
————,—Corn & Cotton	G. T. Bennett,	Mount Olive,	N. C.	24
————,—Hand	P. S. Clinger,	Conestoga Cen.	Penna.	3
Curtain Fixture,	Edward Brown,	Waterbury,	Conn.	3
————	Joseph Smith,	City of	N. Y.	3
————,—Window	Tanner and Gorton,	Paw Paw,	Mich.	3
Cutlery,—Securing Handles of	R. H. Fisher,	Beverly,	N. J.	10
Door Numbers,—Casting	J. T. Fuller,	Louisville,	Ky.	10
Eave Troughs,—Making	Loomis Mann,	Ionia,	Mich.	17
Egg-beater,	J. M. Jay and J. Danner,	Canton,	Ohio,	17
Elevators for Hay, &c.,	F. F. Fowler,	Crane towns'p,	"	17
Emery Cloth,—Substitutes for	Thomas J. Mayall,	Roxbury,	Mass.	10
Enameling Mouldings, Machine	Richard Ten Eyck, Jr.,	Brooklyn,	N. Y.	24
Etching Stone,—Composition for	A. Hoen,	Baltimore,	Md.	24
Evaporators,—Rotary	A. H. Miller,	La Porte,	Ind.	24
Excavators,—Dirt-loading for	William Cooper,	Mount Gilead,	Ohio,	3
Eyelet Machines,	William Steinmetz,	Philadelphia,	Penna.	17
Faucets,—Measuring,	George K. Babcock,	Utica,	N. Y.	3
Fence,—Making Picket	J. Moore and A. Kelly,	Pittsburgh,	Penna.	17
Fertilizers,—Sowing	William D. Mason,	Jarrett's Depot,	Va.	3
Fibrous Materials,—Reducing	S. M. Allen,	Niagara Falls,	N. Y.	17
Figures, &c.,—Copying	F. C. Meyer,	Philadelphia,	Penna.	24
Files,	Pietro Cinquini,	West Meriden,	Conn.	3
Fire-arms,—Breech-loading	J. Letort & H. S. Matthews,	Wytheville,	Va.	3
————————	Calvin Cox,	Coxville,	N. C.	10
————————	G. P. Foster,	Providence,	R. I.	10
————,—Revolving	F. D. Newbury,	Albany,	N. Y.	10
Fire Escape,	Deckelman and Spiess,	City of	"	24
————	Adolphus Lippman,	"	"	24
—— Ladders,—Truck for	Mickle and Carville,	"	"	10
—— Places,	James K. Ross,	Lebanon,	Ohio,	3
————	T. F. Card,	Cincinnati,	"	17
—— Plugs,—Casting	Wm. M. and J. B. Ellis,	Washington,	D. C.	17
Fire-proof Safes,	Gregor Menzel,	Milwaukie,	Wis.	24
Flour Separators,	Stephen Hughes,	Hamilton,	Ohio,	17
Fluid Lenses,	Seligman Kakeles,	City of	N. Y.	24
Fly Brush or Fan,	Marcus Laveen,	Moorefield,	Va.	10
Forge Bellows,	William Thompson,	Detroit,	Mich.	17
Fork and Spoon,—Culinary	Andrew Hills,	Naugatuck,	Conn.	10
Furnaces,	Peter Low,	Cincinnati,	Ohio,	3

Garden Hoes, .	John R. Albertson, .	E. Deertowns'p,	Penna.	3
Gas,—Instruments for Lighting	Damarin and Brower,	New Orleans,	La.	24
—— Lights,—Reflector for	Isaac P. Frink, .	Newark,	N. J.	17
—— Metres,—Dry .	Charles L. Vasquez,	Philadelphia,	Penna.	10
—— Retorts,—Siphons to	Harvey Guild, .	New Orleans,	La.	3
Gases,—for Generating	Samuel Chamberlaine,	Philadelphia,	Penna.	10
Glass Moulds, .	C. H. Warner, .	Brooklyn,	N. Y.	10
Grain by Sulph. acid,—Bleach'g	J. M. Clark, .	Philadelphia,	Penna.	17
—— Drying Machines,	T. H. McCulloch, .	Peoria,	Ill.	17
—— Scales,—Automatic	Albert Gummer,	Indianapolis,	Ind.	3
—— Separators, .	Jacob Schaefer, .	Henderson,	Ky.	10
———— .	J. H. McGehee, .	Athens,	Ala.	17
———— .	George Westinghouse,	Schenectady,	N. Y.	17
———— .	J. A. Vaughn, .	Cuyahoga Falls,	Ohio,	24
——,—Weighing .	John Williams, .	Kalamazoo,	Mich.	10
Gum from machinery,—Remov'g	Samuel Maxwell,	Baltimore,	Md.	24
Hammers,—Atmospheric	Milo Peck, .	New Haven,	Conn.	17
Hand Trucks, .	Jonas Underkofler,	Philadelphia,	Penna.	24
Harness Pads, .	James Ives, .	Mount Carmel,	Conn.	24
Harvesters, .	Jacob L. Paxson,	Norristown,	Penna.	10
———— .	Lewis C. Reese, .	Phillipsburgh,	N. J.	10
———— .	A. and N. Kane,	City of	N. Y.	24
————,—Cutting appa's for	George Fetter, .	Philadelphia,	Penna.	3
————,—Rakes for	W. P. Penn, .	Belleville,	Ill.	24
Harvesting Machines, .	Bennett F. Witt, .	Dublin,	Ind.	10
————————	Martin Hallenbeck,	Albany,	N. Y.	17
Hat Rack for Cigars, &c.,	Charles Branwhite, .	Williamsburgh,	"	24
Hats, .	J. R. Ender, .	Trenton,	La.	17
——,—Manufacture of .	Warburton and Lovett,	Philadelphia,	Penna.	10
——,—Ventilators for	James Jenkinson,	Brooklyn,	N. Y.	24
———————— .	Julius Pollock, .	Morrisania,	"	3
Head-supporting Apparatus,	Henry C. Howells,	City of	"	10
Heat Radiators, .	D. G. Fletcher, .	Racine,	Wis.	17
Hoisting Hay, &c.,—Machines	J. S. Lloyd, .	Salem,	N. J.	24
Hoisting Wheels,—Operating	John McMurtry, .	Fayette Co.,	Ky.	3
Horses Feet from Interfering	William Somerville,	City of	N. Y.	24
——,—Stopping Runaway	Joseph Koehler, .	"	"	17
Horse-powers, .	Charles S. Graves,	Elyria,	Ohio,	10
———— .	E. B. Requa, .	Jersey City,	N. J.	17
———— .	Otis W. Stanford,	Cincinnati,	Ohio,	24
Horse-shoe Machine,	T. R. Taylor, .	Cleveland,	"	3
Hose Tubing, .	Charles McBurney,	Roxbury,	Mass.	10
Iron,—Manufacture of	W. G. Brown & F. McKee,	Birmingham,	Penna.	3
——,—Welding Wrought	J. C. Cooke, .	Middletown,	Conn.	3
Journal Boxes, .	I. P. Wendell, .	Philadelphia,	Penna.	10
Knife and Fork Cleaner,	Sewall Brackett,	Fall River,	Mass.	10
—— Sharpener and Cleaner,	John M. Farman, .	Hartford,	Conn.	17
Ladder,—Extension .	Mickle and Carville,	City of	N. Y.	10
Ladders,—Extension	F. Kavemann and others,	Cincinnati,	Ohio,	24
Lanterns, .	P. A. Morley, .	Brooklyn,	N. Y.	17
———— .	T. B. DeForest, .	City of	"	10
Lathes, .	John Cook, .	Buffalo,	"	3
Leather-dressing Machine,	R. P. Boyce, .	Erata,	Miss.	17
Letter-copying Presses, .	G. C. Taft, .	Worcester,	Mass.	24
Lightning Rods,—Insulating &c.	Myron Fox, .	Stamford,	Conn.	24
Lock, . .	William E. Worthen,	City of	N. Y.	10
—— and Label sheath,—comp.	Samuel W. Marsh,	Washington,	D. C.	3
Locomotives,—Guide Wheels for	Septimus Norris, .	Philadelphia,	Penna.	24
Locom. Engs.,—Running Gear	John L. Whetstone,	Cincinnati,	Ohio,	10
Looking-glass or Mirror, .	S. F. Brooks, .	Weston,	Mass.	24
Looms, .	James C. Cooke,	Middletown,	Conn.	10

Looms,	Hezekiah Conant,	Willimantic,	Conn.	10
Lubricating Carriage Axles,	James E. Emerson,	San Francisco,	Cal.	17
Mail Bags, &c.,—Labels for	T. P. Trott,	Washington,	D. C.	24
Mangers,	John E. Kelly,	City of	N. Y.	10
Mangle,	George Coombs,	West Falls,	"	17
Match Case,—Portable	D. Ellis and P. Hine,	Waterbury,	Conn.	24
Mills,—Grinding	Edmund Munson,	Utica,	N. Y.	3
Millstone Bush,	Moses French,	Leesville,	Ind.	3
Molasses Gates,—Casting	M. R. Chace,	Fall River,	Mass.	24
Mortising Machine,	Lovett Eames,	Kalamazoo,	Mich.	17
——— Tool,	"	"	"	10
Mosquito Fan,—Automatic	Charles A. Gale,	Boston,	Mass.	10
Mowing Machines,	S. Ray & M. P. Shalters,	Alliance,	Ohio,	10
Needle Case,	T. G. Harold,	Brooklyn,	N. Y.	24
——— Guards,	Joseph C. Howells,	Madison,	Wis.	10
Oil Cans,	William C. Arthur,	Baltimore,	Md.	10
—— Cock,	James Hare, Jr.,	Paterson,	N. J.	17
—,—Distillation of Coal	Stombs and Brace,	Newport,	Ky.	10
Oils,———————	Luther Atwood,	City of	N. Y.	10
—,———————Hydro-carb.	"	"	"	10
Ore,—Apparatus for Heating	A. C. Vandyke,	Greenupsburg,	Ky.	24
Ores of Zinc, &c.,—Operations to	Robert George,	Mineral Point,	Wis.	3
Paddle Wheel,	Rollin Germain,	Buffalo,	N. Y.	10
Padlock,	Wilson Bohannan,	Baltimore,	Md.	17
Paper-bag Cutter,	L. D. Barraud,	City of	N. Y.	24
Pen and Pencil Case,	John Cockburn,	"	"	10
—— Stand,	Rooney and Renshaw,	"	"	3
Planes in Moulding,—Adjusting	W. D. Jones,	Dayton,	Ohio,	24
Ploughs,	D. H. and E. E. Smith,	Glenn Spring,	S. C.	3
———	A. Hammond,	Jacksonville,	Ill.	10
———	William D. Ivey,	Milford,	Ga.	10
———	M. C. McCullers,	Herndon,	"	24
———,—Mole	Wall, Roberts & Carter,	Decatur,	Ill.	10
———,—Seeding	C. Atkinson,	Vermont,	"	10
———————	James Peeler,	Tallahassee,	Fla.	24
Printing Presses,	F. O. Degener,	City of	N. Y.	24
Prussian Blue,—Manufacture of	Theodore A. Helwig,	Minersville,	Penna.	3
Pumps,	Cornelius Hood,	Seneca Falls,	N. Y.	17
———	Henry Belfield,	Philadelphia,	Penna.	17
———	Robert Ramsden,	S. Easton,	"	24
———	Levi Matthews,	Antrim,	Ohio,	24
Pumping Water,—Wind Mach.	F. G. Johnson,	Sag Harbor,	N. Y.	3
Pump Valves,	William Jeffers,	Pawtucket,	R. I.	17
Punches,	Adoniram J. Fullom,	Springfield,	Vt.	10
Quartz,—Machines for Crushing	Jefferson Short,	Leavenworth,	K. T.	17
——— Mills,—Grind. Surfaces	Ezra Coleman,	City of	N. Y.	3
Railroad Axle Boxes,	Harvey Rice,	Concord,	N. H.	3
——— Car Axles,	James Montgomery,	Baltimore,	Md.	24
——— Cars,	S. J. Seely,	Buffalo,	N. Y.	24
———,—Brakes for City	Jenks and Steere,	Providence,	R. I.	17
———,—Framing of	Thomas M. Mullen,	Philadelphia,	Penna.	3
———,—Running Gear	Richard Hornbrook,	Cincinnati,	Ohio,	24
———,—Starting City	Solomon N. Sanford,	Cleveland,	"	3
——— Rails, &c.,—Wear of	C. T. Liernur,	Mobile,	Ala.	17
Railroads,—Tracks for City	S. M. Fox,	City of	N. Y.	24
Rakes,—Horse	Lorenzo Beach,	Montrose,	Penna.	10
Reflector,—Night-light	John Wyberd,	City of	N. Y.	10
Refrigerator,	W. M. Baker,	Walpole,	Ind.	3
Roofing,—Board	Freeman Walcott,	Milford,	Mass.	10
Rotary Motion,—Reciprocat'g to	Joshua Hathaway,	Marietta,	Ga.	3

Saddles,—Riding	John E. Kelly,	City of	N. Y.	3
———	Mortimer Nelson,	"	"	10
Sashes,—Metallic	W. E. Worthen,	"	"	24
Sausage-stuffer,	Christian Kramer,	Alleghany,	Penna.	3
———	Salmon R. Plumb,	Southington,	Conn.	10
———	John G. Perry,	S. Kingston,	R. I.	10
Saw-filer,	J. S. Tripp,	Danby,	N. Y.	17
Saw-mills,	C. P. Morton,	Philadelphia,	Penna.	24
Saws,	Pearson Crosby,	City of	N. Y.	10
Scaffolds,—Builders'	John K. Lemon,	Toledo,	Ohio,	10
Scales,	H. N. and J. C. Bill,	Willimantic,	Conn.	3
Scissors,	Francis B. Bowman,	Waltham,	Mass.	3
Seed Planters,	John Robinson,	Sharptown,	Md.	17
Seeding Harrows,	William Finlay,	Schoolcraft,	Mich.	10
——— Machines,	James F. Gyles,	Gilmer towns'p,	Ill.	3
———	Alonzo R. Root,	Canton,	Mo.	3
———	A. and R. B. McElroy,	Waupun,	Wis.	3
———	F. Chamberlin,	Berlin,	"	10
———	Thomas Lindsey,	Lincoln,	Ill.	10
———,—Broadcast	John Barnes,	Lima,	N. Y.	24
Sewing Machines,	Thomas Newlove,	Chicago,	Ill.	3
———	Warren Millar,	"	"	10
———	Allen & Molyneux,	Bordentown,	N. J.	17
———,—Driv. mech.	Jonas Perkins,	Braintree,	Mass.	17
——— Machine,—Stitch of a	J. S. McCurdy,	Brooklyn,	N. Y.	24
——— Machines,—Tension ap.	C. G. Cross,	Chicago,	Ill.	17
——— Mach. needles,—thread'g	John Stevens,	City of	N. Y.	3
Sextant,	Louis Daser,	Washington,	D. C.	17
Sheet Metal,—Cutting	John Waugh,	Elmira,	N. Y.	24
Shingle Machines,—Tilt'g bolt	Tyrannus P. Butterfield,	Indianapolis,	Ind.	3
Shirt Stud,	Henry Simon,	Providence,	R. I.	10
Shoemakers' Awls,	B. J. Lane,	S Framingham,	Mass.	17
Show-case Doors,	Daniel Barclay,	Chicago,	Ill.	24
Skates,	Bradford Stetson,	Uxbridge,	Mass.	24
Slate,—Artificial	Thomas J. Mayall,	Roxbury,	"	10
—— Roof,—Laying	Isaac Mott,	Glenn's Falls,	N. Y.	10
Sofa Bedstead,	William H. Tendler,	Cambridge,	Mass.	10
Sowing Machines,	W. W. Williams,	Elizabeth City,	N. C.	3
Staging-supporter for mechanics,	Azel Reynolds, Jr.,	N. Bridgewater,	Mass.	17
Steam Boiler,	Stone and Whipple,	Roxb'y&Boston,	"	10
———	E. W. Tarbell,	Boston,	"	17
———	B. H. Wright,	Rome,	N. Y.	24
——— Boilers,	James Montgomery,	Baltimore,	Md.	17
———,—Feed Water	Thomas Snowdon,	Pittsburgh,	Penna.	3
———	C. and G. M. Woodward,	City of	N. Y.	10
———	Henry Giffard,	Paris,	France,	24
———	G. W. Rains,	Newburgh,	N. Y.	24
———,—Gauge, &c., for	James Montgomery,	Baltimore,	Md.	24
———,—Spark-extin.	D. S. Harris,	Galena,	Ill.	10
———,—Test'g floats	George W. Lane,	Boston,	Mass.	3
——— Carriages,	J. V. Merrick,	Philadelphia,	Penna.	17
——— Engines,	Frank Douglas,	Norwich,	Conn.	3
———	Ormrod C. Evans,	City of	N. Y.	10
———,—Gov. Valves of	P. L. Weimer,	Lebanon,	Penna.	3
———	Edward Armstrong,	Pittsburgh,	"	3
———	P. L. Weimer,	Lebanon,	"	17
——— Generators,	R. E. Rogers,	Philadelphia,	"	17
——— Trap Valve,	John Avery, Jr.,	City of	N. Y.	10
———	Daniel Lee,	Boston,	Mass.	17
Steel,—Manufacture of	A. K. Eaton,	City of	N. Y.	3
Steering Apparatus,	William W. Huse,	Brooklyn,	"	10
Stones,—Machines for Breaking	E. W. Blake,	New Haven,	Conn.	17
———,—Crushing	G. H. Wood,	Green Bay,	Wis.	24

Stones,—Stamping & Crushing	Jeremiah Stever,	Bristol,	Conn.	3
Stoves,	W. J. Cantilo,	Philadelphia,	Penna.	24
———,—Cooking	Joseph C. Henderson,	Albany,	N. Y.	3
Straw-cutters,	C. B. Mallory,	Fredonia,	"	3
———	Root and Lloyd,	Muncy,	Penna.	17
Stump Extractors,	L. C. English,	Canton,	N. Y.	17
———	Caleb Bates,	Kingston,	Mass.	17
Sugar Cane,—Crushing	Theodore Grundman,	Freeport,	Ill.	17
——— Holder & Distributor,	Thomas Lewis,	Malden,	Mass.	3
——— Juices,—Evaporating	Seth W. Eells,	Mansfield,	Ohio,	10
——— Mills,	G. W. L. Hazen,	Indianapolis,	Ind.	17
———,—Crushing Rollers	Philetus W. Gates,	Chicago,	Ill.	10
Sweeping Streets,	Robert A. Smith,	City of	N. Y.	10
Swing,—Portable	L. K. Selden,	Haddam,	Conn.	24
Tanning,	David Needham,	Oskaloosa,	Iowa,	10
———,—Concen. Extracts	James Connell,	Port Huron,	Mich.	10
———,—Method of	M. A. Bell,	Rushford,	N. Y.	24
Teeth,—Fastening Artificial	A. M. and J. L. Asay,	Philadelphia,	Penna.	3
Telegraph Wires,—Insulating	John M. Batchelder,	Cambridge,	Mass.	10
Temples for Looms,	J. H. Woodward,	Nashua,	N. H.	24
Thread and Yarn,—Manufac. of	S. M. Allen,	Niagara Falls,	N. Y.	17
Thills to Vehicles,—Attaching	L. W. Boynton,	City of	"	3
Tire,—Upsetting	Leonard Kile,	Williamsfield,	Ohio,	10
Tobacco Presses,	E. S. Collins,	Aspen Wall,	Va.	17
Tombstones,	Thomas Windell,	New Albany,	Ind.	24
Trap,—Animal	Levi W. Buxton,	Nashua,	N. H.	24
Traveling Bags,	T. R. Dunham,	Newark,	N. J.	24
Trip Hammer,	David Howell,	Louisville,	Ky.	10
Valves,	Joseph Higginbotham,	Philadelphia,	Penna.	10
Vapor Burners,	Edward H. Anderson,	Easton,	Md.	3
———	Hopkins & Anderson,	"	"	3
———	Oscar F. Morrill,	Boston,	Mass.	3
——— Lamps,	Henry Johnson,	Washington,	D. C.	17
Varnish,	André Sabatier,	City of	N. Y.	10
Veneers,—Machines for Cutting	David Donald,	"	"	17
———	Koch and Stoeckel,	"	"	24
Vessels of Sheet Metal,—Form'g	J. B. Jones,	Brooklyn (E D),	"	17
Voting Register,	J. W. Wetmore,	Erie,	Penna.	3
Vulcanized Rubber,—Restoring	C. F. E. Simon,	Washington t'n,	N. J.	10
Walls,—Building Concrete	Elizur E. Clark,	New Haven,	Conn.	3
———	"	"	"	24
Warming Apparatus,—Draft in	Brown and Ellis,	City of	N. Y.	3
Washboard,	Joseph Keech,	Waterloo,	"	10
———	Edward Hatfield,	Brownsville,	Penna.	10
Washing Machine,	Burgan B. Wescott,	Camden,	Ind.	10
———	Patterson and Morell,	Woodbury,	N. J.	10
———	Josee Johnson,	City of	N. Y.	10
———	Sharp and Mood,	Ithaca,	"	10
———	H. C. Smith,	Cleveland,	Ohio,	10
———	C. K. Williams,	Haddonfield,	N. J.	17
———	G. W. Tolhurst,	Liverpool,	Ohio,	24
Water Elevators,	James Aldrich,	Washington,	D. C.	10
Well Buckets,	Daniel D. Farnham,	Johnstown Cen.	Wis.	3
Wheels for Artillery Carriages,	John D. Murphy,	Baltimore,	Md.	3
Whiffle-trees,—Self-detaching	S. D. Bowker,	Geneva,	Ohio,	17
Window-blind Slat Machine,	H. W. Farmer,	Poultney,	Vt.	24
Window-sash Supporters,	J. W. Briggs,	Cleveland,	Ohio,	17
Window Sashes,	McCoy and Muth,	Wheeling,	Va.	24
———,—Supporting	David C. Lyall,	City of	N. Y.	10
Wind-mills,	E. F. M. Fletcher,	Georgia Plains,	Vt.	17
Wood,—Polishing	George Munger,	New Haven,	Conn.	17
Wooden Ware,—Making	Ansel Howard,	Readsborough,	Vt.	10
Writing Desk,—Reading and	Carl Pretsch,	Trenton,	N. J.	10

EXTENSIONS.

Curry-combs, .	William Wheeler,	New Britain,	Conn.	17
Door Locks, .	Joshua H. Butterworth,	Dover,	N. J.	3
Hat-bodies,—Making, .	Eliza Wells, .	City of	N. Y.	24
———,—Manufacturing	" .	"	"	24
Printing Presses,—Checking	Alva B. Taylor,	"	"	3
Saw-mills, .	Thomas J. Wells, .	"	"	3
Stoves,—Registers of .	Washburn Race,	Seneca Falls,	"	10
Telegraphs,—Electro-magnetic	S. F. B. Morse, .	Poughkeepsie,	"	17
Telegraph,—Mag. Letter Print'g	R. E. House, .	Binghampton,	"	24

ADDITIONAL IMPROVEMENTS.

Canal Boat Propellers, .	Robert Cartwright, .	Ithaca,	N. Y.	3
Coffee Pots, .	H. P. Gatchell, .	Ravenna,	Ohio,	3
Harvesters,—Cutters for .	John Gore, .	Brattleboro',	Vt.	10
Windlasses,—Ship's	James Emerson,	Boston,	Mass.	3

RE-ISSUES.

Boiler-feeder,—Automatic	S. B. Hunt, .	City of	N. Y.	24
Enameling Moldings,	Robert Marcher,	"	"	3
Folding Paper, .	George K. Snow, .	Watertown,	Mass.	3
Knitting Machines,	Clark Tompkins,	Troy,	N. Y.	24
Looms for Figured Fabrics,	Moses Marshall, .	Lowell,	Mass.	24
Manure Excavators,	Abraham R. Hurst,	Chambersburg,	Penna.	3
Matrices,—Mode of constructing	J. C. Smith, .	Philadelphia,	"	10
Planing Lumber "out of Wind,"	S S Gray & S A Woods,	Boston,	Mass.	17
Railroads,—Dispensing switches	Wm. Wharton, Jr., .	Philadelphia,	Penna.	3
Stoppers for Bottles,—Glass	T. R. Hartell, .	"	"	24
Stoves,—Coal .	C. Eddy and J. Shavor,	Troy,	N. Y.	10
Straw-cutters, .	Warren Gale, .	Chicopee Falls,	Mass.	3

DESIGNS.

Andirons, (2 cases,) .	Samuel Boyd, .	City of	N. Y.	3
Carpets, .	David McNair, .	Roxbury,	Mass.	3
———, .	Francis J. Pierce, .	Lowell,	"	3
Coffins, .	James C. Karr, .	Williamson co.,	Tenn.	3
Cooking Range, .	J. Martino & J. Horton,	Philadelphia,	Penna.	10
Fire-dogs (6 cases,)	Theodore W. Lillagore,	"	"	3
Floor Cloth, .	Jeremiah Meyer, .	City of	N. Y.	24
——- Oil Cloth, .	J. B. Virolet, .	"	"	24
Ice Pitchers, .	George W. Smith, .	Hartford,	Conn.	3
Paint Cans, (3 cases,)	W. L. Gilroy, .	Philadelphia,	Penna.	24
—— Vessels, .	" .	"	"	24
Spoon Handles, .	John Polhamus, .	City of	N. Y.	10
Lead Pencils,—Stamping on	Joseph Rosenthal, .	"	"	3
Stoves, .	N. S. Vedder, .	Troy,	"	24
———,—Parlor .	Isaac De Zouche, .	St. Louis,	Mo.	24
Trade-marks for Lead Pencils,	Joseph Rosenthal,	City of	N. Y.	3
Trade-mark for Neuralgic Pills,	Samuel Armitage, .	St. Louis,	Mo.	3
Water Coolers, .	Charles Muller, .	City of	N. Y.	3

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, June 21, 1860.

John C. Cresson, President, in the chair.
John Agnew, Vice-President,
Isaac B. Garrigues, Recording Secretary, } Present.
The minutes of the last meeting were read and approved.

Donations to the Library were received from the Royal Astronomical Society, The Chemical Society, and the Institute of Actuaries of London; the Oesterreichischen Ingenieur-Vereines, Vienna, Austria; the Regents of the University of New York, Albany, N. Y.; F. H. Storer, Esq., Cambridge, Mass.; the Ohio Mechanics' Institute, Cincinnati, Ohio; the State Agricultural Society, Madison, Wisconsin; and from Dr. Alexander Wilcocks, Prof. John F. Frazer, and the American Philosophical Society, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer read his statement of the receipts and payments for the month of May.

The Board of Managers and Standing Committees reported their minutes.

Candidates for membership in the Institute (5) were proposed, and the candidates proposed at the last meeting (4) duly elected.

In compliance with a request from the Committee on Meetings, the President gave a brief description of the large balloon of Professor Lowe, with which he proposes to attempt a transatlantic voyage. Its dimensions were stated to be 110 feet in horizontal diameter, and about 120 in height; the cubical capacity being 700,000 cubic feet. The idea of the æronaut is to inflate with about one-half the quantity of gas the balloon will hold, so as to allow room for expansion as the machine rises. The buoyancy of the ordinary coal gas being about 40 lbs. to the thousand feet, the buoyant power with this degree of inflation will be about 14,000 lbs., of which about 5000 lbs. will be required to sustain the balloon and trappings, including a life-boat, with sails, &c. The remaining floating power beyond the weight of passengers and provisions, will be balanced by portable ballast, which is to be thrown overboard as occasion requires. Prof. Lowe expects to rise to the height of three miles, and there travel East-by-North in the prevailing upper current of the atmosphere, which he supposes to have a velocity of nearly 100 miles an hour, and will therefore waft him across the Atlantic in less than two days.

COMMITTEE ON SCIENCE AND THE ARTS.

Report on Ritchie's Rhumkorff's Induction Apparatus.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination—"An Improvement on Rhumkorff's Induction Apparatus," by E. S. Ritchie, of Boston, Massachusetts,

REPORT:—That, as it appears from the description of the apparatus by Mr. Ritchie, hereto annexed; his apparatus differs from those made before him in the following particulars:—

In making the primary helix of greater diameter, and of larger wire; the iron core is made longer than the helix; the primary helix is insulated more thoroughly from the secondary, by a glass bell with a broad flanch below, on which the secondary coil rests; the secondary coil is wound differently, in place of winding in successive helices, it is wound by spirals alternately outward and inward, beginning with the base. In this way, it will be seen that between any two points nearly in contact, there is less difference of intensity than in the old mode, and thus less thickness of insulating material is required, and a greater length of coil can be put within the inductive influence. This secondary helix is also more carefully covered with insulating material; the condenser (which is Fizeau's invention) is divided into three sections, so that the power of the instrument may be modified by the use of one, two, or all of the parts. The interrupter is modified and placed under the control of the operator, by which a more sudden and slower brake can be made, and thus the power of the instrument increased.

The Committee have experimented upon the apparatus constructed by Mr. Ritchie, for the Department of Arts of the University of Pennsylvania, and they find that this apparatus excited by three cells of a carbon battery, the zincs of which are five inches in diameter and eleven inches in height, is capable of giving a spark of eleven inches in length; while, so far as the Committee is aware, no spark over three inches has ever been obtained, either by Rhumkorff or his English improver, Hearder, until after an instrument constructed by Mr. Ritchie on this plan had been sent to England; and even now a spark of the same length from one of those instruments requires much larger batteries than those of Mr. Ritchie.

The Committee regard the modifications which Mr. Ritchie has introduced into the apparatus as improvements, and his mode of winding the coil, especially, as novel, ingenious, and highly valuable; and believing that this apparatus is destined to be of great importance in the arts, owing to the economy, simplicity, and energy with which it generates a powerful electric current; and regarding some of the modifications of Mr. Ritchie to be original and of great utility, they recommend the award of the *Scott's Legacy Medal and Premium* to Mr. E. S. Ritchie, of Boston, for his Improved Rhumkorff's Induction Apparatus.

By order of the Committee,

WM. HAMILTON, *Actuary.*

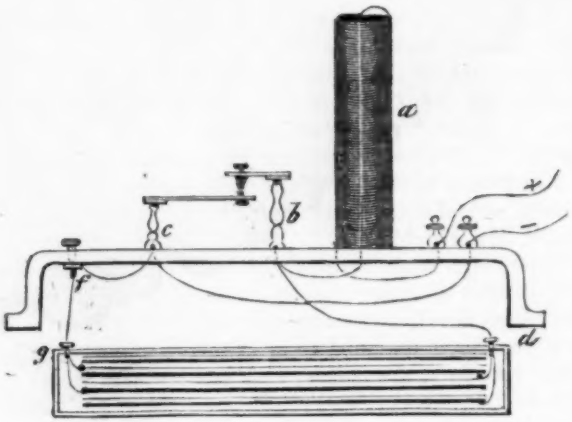
Philadelphia, May 10th, 1860.

Description of Ritchie's Rhumkorff's Induction Apparatus.

The primary helix is made of No. 9 copper wire, which is about $\frac{1}{4}$th of an inch in diameter, insulated, and wound in three courses; its length is about 180 feet, and it encloses a bundle of carefully annealed

iron wire of about $1\frac{1}{2}$ inches in diameter. Wires are used instead of a solid bar as they can be more readily and perfectly annealed. One end of the wire of the primary helix passes directly to a pole cup for connecting with the battery; the other end of the wire connects with the pillar, *b*, carrying a screw capped with platinum. This is in contact with a similar platinum cap on a spring, supported upon a pillar, *c*. This pillar connects with the other pole cup. When the battery is attached, the iron bundle or core becomes a powerful electro-magnet, but is demagnetized by breaking the circuit, by depressing the spring, separating the platinum caps. This is called the "interrupter," or "break-piece." The hammer and ratchet wheel are to effect this interruption at pleasure. Over this primary is placed for insulation a bell glass, and over the bell glass is placed the

Secondary helix.—This is made of insulated copper wire of one-eightieth of an inch diameter, covered with silk, and of about sixteen miles in length. The terminals are conducted for convenience to glass pillars furnished with discharging rods.



+ AND — BATTERY WIRES.

a, Primary Helix. One wire connects with + pole; the other passes to pillar (*b*). The circuit is completed through pillar (*c*) to the other pole cup.

b connects directly with knob of condenser, by a wire, at (*d*).

c connects through screw *f* with knob of condenser; or three screws at *f* bear upon 3 knobs (*g*), which each has a separate bundle of condensers. The alternate sheets of all are united at the opposite pole at *d*.

Thus far the instrument is in principle the same that has been in use for years, though incapable of throwing a spark in the air across an interval. But connected with the interruptor is a

Condenser, due to Fizeau. This is simply a Leyden jar of great surface, and is made of oiled silk with coatings of tin foil. The silk is in sheets, about 18 by 10 inches, piled up with intervening sheets of foil, a little smaller in size. Every other sheet of foil is connected by a small ribbon of foil, extending out on one side, while the alternate sheets of foil are similarly connected by ribbons, extending on the opposite side. The whole pile is enclosed for convenience in a box, and placed within the basement. The two bundles of ribbons of foil, connect with two pieces of metal coming through the cover of the box; the whole may be considered as a battery of Leyden jars, and

these metallic pieces are the discharging knobs. When the box is in place, these knobs connect with the two pillars above mentioned; so that each cap of platinum of the interrupter is in metallic connexion, the one with one side of the Leyden jar, the other cap with the opposite side of the Leyden jar.

On the opposite page is a drawing which will show the connexions.

I will now give the particulars in which my instrument differs from those previously constructed.

I use a primary helix of larger proportionate diameter and of larger wire. The iron core I make much longer than either the primary or secondary helix (these are of equal length); the core I make from 50 to 100 per cent. longer. The intensity of an electro-magnet being greatest at the middle, I thus obtain a more intense magnetic force, and the intensity and volume of the induced current is much increased.

I insulate the two helices much more perfectly. Glass tubes have been used, but as the discharges took place through the iron core, I closed one end, making the tube into a bell glass, and still further added to its effect by making a flanch project from the lower edge.

In all previously constructed instruments, the secondary helix was wound longitudinally as a spool of thread, each course or stratum being insulated from the next by gutta percha or other material; but after many courses are thus laid, the intensity becomes sufficient for the spark to break through or pass around from the outer to the inner stratum, and consequently the limits of power were soon reached, and the longest spark obtained was not over three inches. Rhumkorff had then obtained but about half an inch with a single instrument. Much greater intensity in this form is impossible, as each insulation must be increased proportionately in thickness, and this would carry the outer strata beyond the influence of the iron core. I devised a mode of winding the helix which obviated this difficulty. I wind my helix in strata perpendicular to the helix, and wind it as a sailor coils a rope upon the deck: beginning with a small circle, he winds arounds this his rope until the circle is as large as desirable; he lays a turn upon this last one, and commences a second stratum or layer, winding now each turn within the last, until he reaches the size of circle he commenced with; again, a third stratum upon this.

I build my coil in the same manner. I make a cylinder of gutta percha, with a flanch or head as large in diameter as the coil is to be. Each stratum is parallel with the head and between each is an insulation; but as I now only desire to prevent the spark from leaping from the wire where one layer is commenced to the wire where the next lies upon it (and the length is but a few hundred feet), a very thin insulation is enough, and a disc of oiled silk is sufficient. The helix can be built up indefinitely, as I make the section no deeper than that the intensity obtained in each stratum equals its thickness with the thickness of insulation. Consequently, if the spark cannot leap further than from layer No. 1 to No. 2, it cannot leap to the 3d, or the 10th, or the 100th, because the *distance* from the 1st to the 3d and

10th, &c., is proportionately greater—when wound longitudinally it is otherwise. A sufficient insulation may protect No. 1 from No. 2 course, but No. 10 has ten times the intensity, and is necessarily brought very near No. 1, and the insulation fails. In this case the coil is ruined. But, as I wind it, if battery force is put on enough to make the spark leap its entire length, it does no harm.

I also cover the helix outside, sometimes entirely and sometimes only the lower portion, with gutta percha.

In previously-constructed instruments, the interrupter used was De La Rive's automatic break-piece. I found this far too rapid, that *time* was required, and that for different results a very varied rate is requisite; also, that a *sudden* break is more effective. I devised the interrupter to meet these requirements, and place the discharges more in control of the operator. By my interrupter, a longer and a far more voluminous discharge is produced.

I divide the condenser into two or three parts, and connect each through a screw, so that either or all may be used, or all may be disconnected.

To introduce these changes, of course the entire form and arrangement of parts are different from all others.

So far as I have information, not until after I had published my mode of constructing this instrument and had sent one to the order of Gassiot, of London, throwing over twelve inches, had any been made of over three inches of spark.

I respectfully submit the instrument with these explanations to the Committee on Science and the Arts of the Franklin Institute.

E. S. Ritchie.

Boston, Dec. 10, 1858.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By James A. Kirkpatrick, A.M.

May.—The month of May, 1860, was distinguished for its thunder storms, and the number of days on which rain fell. There were no less than eight thunder storms at Philadelphia during the month, though but little damage resulted from them here. Those of the 21st and 30th of the month, however, were very violent and destructive; the former in Ohio, and the latter in the north-western part of Pennsylvania.

Rain fell at Philadelphia on nineteen days of the thirty-one, showing a greater number of rainy days than has ever before been noticed in the month of May. In May, 1858, rain fell on eighteen days, and in 1853 and 1854, on fifteen days. The average number of rainy days for the month of May, during nine years, is thirteen.

The mean temperature of the month was less than 1° above the average, while it was about half a degree colder than May, 1859.

The warmest day of the month was the 25th, of which the average temperature was 74·3°. The 7th, however, was almost as warm, having an average temperature of 74·0°. The thermometer was highest on the 7th, reaching 90° about 2½ P. M. The thermometer was lowest on the morning of the 1st, when it indicated 44°. The 1st was also the coldest day, the average temperature being 47·7°.

The barometer was highest (30·050) on the 12th, and lowest (29·479) on the 19th of the month. There was a period of low barometer, extending from the 17th till the 24th, reaching the minimum about 4 P. M. on the 19th, a day or so before the storm so destructive to life and property occurred in the west. A similar, though less marked fall in the barometer occurred on the 30th and the 31st of the month.

An inspection of the following table will show another illustration of the fact alluded to in the *Journal* for the last month in relation to the close coincidence of the average barometric height for the month, with that for 9 P. M. During last May the average height for 9 P. M. was but ·005 of an inch higher than the average for the month. During the month of May, 1859, it was but ·002 of an inch higher; and for the same month, for nine years, it stood only ·003 of an inch higher at 9 P. M. than the monthly average for the same period.

A Comparison of some of the Meteorological Phenomena of May, 1860, with those of May, 1859, and of the same month for nine years, at Philadelphia.

	May, 1860.	May, 1859.	May, 9 years.
Thermometer.—Highest,	90°	87°	90°
" Lowest,	44	44	35
" Daily oscillation,	17·20	19·70	16·60
" Mean daily range,	5·20	5·70	5·60
" Means at 7 A. M.,	59·66	59·66	58·47
" " 2 P. M.,	71·03	72·24	69·79
" " 9 P. M.,	61·57	62·06	61.61
" " for the month,	64·09	64·65	63·29
Barometer.—Highest,	30·050 in.	30·176 in.	30·338 in.
" Lowest,	29·479	29·512	29·386
" Mean daily range,	·100	·111	·121
" Means at 7 A. M.,	29·828	29·894	29·843
" " 2 P. M.,	29·787	29·853	29·809
" " 9 P. M.,	29·815	29·876	29·830
" " for the month,	29·810	29·874	29·827
Force of Vapor—Means at 7 A. M.	·395 in.	·361 in.	·361 in.
" " " 2 P. M.	·421	·383	·383
" " " 9 P. M.	·420	·393	·383
Relative Humidity at 7 A. M.	76 per ct.	70 per ct.	73 per ct.
" " 2 P. M.	57	50	53
" " 9 P. M.	76	69	69
Rain, amount in inches,	3·589	1·946	4·196
Number of days on which rain fell,	19	11	13
Prevailing winds,	N. 59°2′ E.·070	S.7°36′ W.·090	N71°12′ W·099

The amount of rain which fell during the month was nearly twice as much as that which fell in May, 1859, but is still below the average for nine years. The force of vapor and the relative humidity, as will be seen by an inspection of the table, were both considerably higher than usual.

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SPRING.—The Spring, consisting of the months of March, April, and May, was one degree warmer than the average for the last nine years, but a degree and a half cooler than the Spring of 1859.

The barometric observations are almost the same as those for the Spring for nine years, but are considerably higher than for the Spring of 1859. The closeness of the 9 P. M. observations to those for the quarter, are also very apparent in the following table of comparisons.

The number of days on which rain fell was more than the average, although the amount of rain and melted snow which actually fell was three inches less than the average, and four and a half inches less than fell during the Spring months of last year.

A Comparison of the SPRING *of* 1860, *with that of* 1859, *and of the same season for nine years, at Philadelphia.*

	Spring, 1860.	Spring, 1859.	Spring for 9 years.
Thermometer.—Highest,	90°	87°	90°
" Lowest,	25	20	4
" Daily oscillation,	18·10	17·40	15·90
" Mean daily range,	6·00	6·00	6·07
" Means at 7 A. M.,	47·26	49·04	46·59
" " 2 P. M.,	59·98	61·23	58·19
" " 9 P. M.,	51·07	52·78	50·54
" " for the spring,	52·77	54·35	51·77
Barometer.—Highest,	30·303 in.	30·360 in.	30·522 in.
" Lowest,	29·319	29·215	28·884
" Mean daily range,	·133	·174	·164
" Means at 7 A. M.,	29·835	29·798	29·829
" " 2 P. M.,	29·779	29·755	29·785
" " 9 P. M.,	29·813	29·780	29·813
" for the spring,	29·809	29·778	29·809
Force of Vapor—Means at 7 A. M.	·259 in.	·258 in.	·253 in.
" " " 2 P. M.	·277	·274	·273
" " " 9 P. M.	·277	·280	·273
Relative Humidity—Means at 7 A. M.	73 per ct.	69 per ct.	73 per ct.
" " " 2 P. M.	50	49	53
" " " 9 P. M.	68	66	68
Rain and melted snow,	8·558 in.	14·117	11·727
No. of days on which rain or snow fell,	42	38	37
Prevailing winds,	s.76°26′w·119	s.76°32′w.·148	s.73°32′w·198

Abstract of Meteorological Observations for April, 1860; made in Philadelphia, Franklin, Indiana, and Armstrong Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	PHILADELPHIA.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. KIRKPATRICK, Observer.									CHAMBERSBURG, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. WM. HEYSER, Jr., Obs.							INDIANA, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. HILDEBRAND, Obs.			FREEPORT, Armstrong Co. 40° 44′ N. 79° 42′ W. Height, 1000 feet. J. H. BAIRD, Obs.		
April.	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Barom	Thermom.		Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Thermometer.		Prevail'g winds.	Thermometer.		Prevailing winds.
	Mean.	Mean daily range	Mean.	Daily oscillation.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean daily range.		Mean.	Mean daily range.	
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.	°	°	Direc.	°	°	Direc.
1	29·391	·224	55·0	23	7·5	·239	39	0·078	S W.	28·834	48·3	10·0	·309	64	0·180	W.	31·7	22·0	N W.	39·0		(var.)
2	29·675	·284	35·7	14	19·3	·081	31		N W.	29·169	34·0	14·3	·093	41		W.	46·0	14·3	(var.)	28·7	10·3	N E.
3	29·684	·111	43·3	25	8·3	·132	34		S.	29·052	45·7	11·7	·116	36		(var.)	50·7	5·7	(var.)	47·3	18·7	?
4	29·466	·218	55·3	16	12·0	·394	76	0·083	S.	28·851	49·7	6·0	·362	87	0·265	(var.)	42·3	8·3	S W.	50·0	7·3	S W.
○ 5	29·560	·109	54·3	21	5·0	·142	22	0·145	S W.	29·001	53·7	8·0	·150	85		W.	47·3	6·3	N W.	45·0	5·7	(var.)
6	29·781	·221	49·3	16	5·0	·173	36		N W.	29·330	48·3	5·3	·157	38		W.	52·0	11·3	S E.	40·0	5·0	W.
7	30·035	·254	46·8	21	2·5	·161	35		(var.)	29·440	51·3	5·7	·163	28		S W.	60·3	8·3	S W.	53·3	13·3	N E.
8	29·776	·258	54·7	21	7·8	·472	88	0·387	S W.	29·182	55·7	4·3	·238	65	0·526	E.	64·7	7·0	S E.	64·0	10·7	W.
9	29·690	·097	57·7	12	3·0	·500	88	0·645	N N E.	29·184	57·0	11·3	·476	70	0·068	(var.)	58·7	6·0	S E.	62·0	6·7	N E.
10	29·880	·189	45·0	13	12·7	·261	84	} 1·216	E.	29·372	49·7	7·3	·269	67	1·400	E.	43·0	15·7	(var.)	63·3	3·3	S W.
11	29·712	·200	45·3	10	3·0	·282	78		N W.	29·236	51·0	5·3	·236	70	1·305	W.	44·7	11·0	N W.	41·3	22·0	(var.)
☾ 12	29·894	·184	49·8	23	5·5	·172	33	0·003	W N W	29·416	50·3	2·7	·203	42		(var.)	40·7	4·7	W.	46·7	9·3	S W.
13	29·808	·090	50·0	16	3·5	·150	33		W S W.	29·376	47·0	4·0	·110	26		W.	36·3	10·3	N W.	43·3	3·3	(var.)
14	29·798	·060	41·3	22	8·7	·198	74	0·030	S W.	29·315	44·0	4·3	·125	40		W.	39·0	14·7	E N E.	37·3	8·0	(var.)
15	30·071	·273	39·8	18	6·8	·113	38		N W.	29·530	42·0	3·3	·099	29		W.	52·0	13·0	E.	38·0	9·3	N E.
16	29·978	·098	41·7	10	3·2	·254	91	0·450	N E.	29·383	53·7	11·7	·260	78		W.				52·0	14·0	(var.)
17	29·797	·180	60·7	33	19·0	·493	59		S W.	29·345	54·0	14·3	·256	30	0·102	W.				55·7	15·7	W.
18	30·282	·484	48·7	22	12·0	·128	31		N N W.	29·807	46·7	9·3	·157	38		W.	55·0		(var.)	46·3	14·0	(var.)
19	30·193	·111	51·3	25	2·7	·197	35	0·060	S W.	29·673	54·3	7·7	·191	41		W.	52·3	10·7	S E.	55·7	9·3	(var.)
20	29·830	·363	54·7	12	6·7	·377	81	0·067	S W.	29·296	65·3	6·3	·416	57		E.	66·0	13·7	S W.	65·0	9·3	S W.
● 21	29·618	·212	62·7	33	12·7	·481	47		(var.)	29·096	64·3	15·7	·452	44	0·056	W.	66·7	2·0	(var.)	63·7	4·3	(var.)
22	29·716	·098	44·0	10	18·7	·223	69	0·422	N E.	29·154	52·7	15·0	·295	68		(var.)	56·7	10·0	N W.	53·3	10·0	N W.
23	29·737	·041	51·8	15	7·8	·279	62		W S W.	29·224	52·0	2·7	·229	44		W.	45·3	11·3	N W.	43·7	9·7	N W.
24	29·766	·046	47·8	15	4·0	·150	33		N W.	29·286	43·3	8·7	·118	25		W.	39·0	6·3	N W.	37·7	6·0	(var.)
25	29·716	·050	42·5	18	5·3	·220	63	0·060	W S W.	29·194	43·3	4·0	·125	40		W.	35·3	3·7	N W.	36·7	2·7	W.
26	29·863	·147	44·7	23	4·8	·118	29		W N W	29·420	44·7	4·0	·091	23		W.	34·0	4·7	N W.	37·3	5·0	(var.)
27	30·044	·180	49·5	23	4·8	·161	35		(var.)	29·554	49·3	6·0	·129	27		(var.)	41·7	7·7	N W.			?
☽ 28	30·073	·045	52·8	17	8·3	·185	37		(var.)	29·543	51·7	4·7	·204	45	0·065	W.	49·3	7·7	S E.	51·7		?
29	29·976	·097	53·7	17	3·5	·119	21		S E.	29·441	56·7	5·0	·176	30		E.	54·3	5·0	E.	57·7	6·0	N E.
30	29·925	·051	54·5	23	2·8	·163	27		N N E.	29·417	52·7	4·0	·150	23		E.	66·7	9·0	S E.	60·3	4·0	S W.
Means	29·824	·166	49·5	19	7·4	·234	50	3·646	N88½W.	29·293	50·5	7·5	·215	45	3·967	West.	49·0	9·3	N70°W.	48·8	8·3	N62½°W.